FINDING OF TECHNICAL IMPRACTICABILITY:

TI EVALUATION and DETERMINATION

for the MCKIN SUPERFUND SITE

GRAY, MAINE

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September 2000

TECHNICAL IMPRACTICABILITY REPORT AND DETERMINATION MCKIN SUPERFUND SITE GRAY, MAINE

TABLE OF CONTENTS

Tables

Figures

TECHNICAL IMPRACTICABILITY REPORT AND DETERMINATION
MCKIN SUPERFUND SITE
GRAY, MAINE

1.0 Introduction

The United States Environmental Protection Agency (EPA) has prepared this Technical Impracticability (TI) Evaluation Report for the McKin Company Superfund Site in Gray, Maine (Figure 1). This TI Report summarizes the data and current understanding of the geology and hydrogeology present at the Site which are needed to make the determination whether groundwater restoration is technically impracticable and what alternative measures or actions must be undertaken to ensure that the final remedy is protective of human health and the environment.

This evaluation is based on site information contained in various reports prepared by Sevee & Maher Engineers, Inc. and GEI, Inc. for the Potentially Responsible Parties (PRPs) as well as reports prepared by TetraTech NUS and USGS for EPA (see bibliography for the sources). This evaluation follows the format presented in with EPA's September 1993 Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration, Interim Final.

In June 1997, the parties involved in the McKin Site entered into a mediation process in a mutual desire to come to resolution on an appropriate course of action for the Site. This mediation effort culminated in November 1999 when the parties agreed to recommend the resolution described below to their respective managements and/or constituents.

The Potentially Responsible Parties (PRPs, those parties who owned or operated the facility, or generated or transported hazardous waste to the facility, can be liable for clean up costs under the Superfund law) agreed to provide the following:

- Funding for a new public water source for the Gray Water District;

- Payment to the Town of Gray for costs incurred during the mediation process and for future implementation of a zoning ordinance in a defined Institutional Control Zone (ICZ) ;

- Purchase of water rights on properties within the ICZ which could be sub-divided;

- Payment to EPA for costs incurred for response actions; and

- Purchase of an insurance policy for remedial actions for the Royal River should the river not meet the State of Maine's standard within the designated time period.

In addition, the PRPs agreed to perform the following:

- Install and monitor a new series of observation wells to be located along the boundaries of the ICZ; and

- Conduct long-term monitoring of the groundwater, springs, and the Royal River until each meets its applicable standards.

EPA agreed to recommend to its management that EPA undertake the following action:

- Agree that site conditions meet the criteria for a Technical Impracticability waiver for groundwater as set forth in EPA's 1993 guidance;

- Write the TI report;

- Perform the remediation for the contamination present at Boiling Springs;

- Produce the Feasibility Study which details the focused investigation of the contaminant plume immediately upgradient of the Royal River and possible remedial action;

- Amend the 1985 Record of Decision (ROD) which had set forth the remedial activities to treat the site soils and restore the groundwater to drinking water quality. The amended ROD will set forth the remedy discussed in this section based on the TI determination.

The Maine Department of Environmental Protection (Maine DEP), as a co-signor of the 1988 Consent Decree along with EPA and the PRPs, agreed to concur with the TI determination for the groundwater and attenuation of the groundwater which will allow the Royal River to attain the State surface water criteria.

The Town of Gray agreed to recommend to the community that a zoning ordinance be adopted which would prohibit the use of groundwater within the ICZ.

The affected property owners agreed to sell their water rights and accept responsibility for funding any extension of water lines onto their property.

1.1 Purpose of this Report

The purpose of this TI Report is to assess the practicability of achieving ARARs for groundwater and surface water for certain chlorinated volatile organic compounds (VOCs). Trichloroethylene (TCE) and 1,2-dichloroethylene (DCE), have been detected in the groundwater plume from the

McKin facility to the Royal River and vinyl chloride (VC) has been detected in the groundwater plume just prior to its discharge to the Royal River (Figure 2). In addition, TCE has been detected in the Royal River above the Maine Surface Water Quality Criteria (SWQC) from the groundwater discharge zone down to sampling location SW-1 and beyond (Figure 3).

1.2 Scope of the Technical Impracticability Report

The EPA guidance sets out the scope for the TI evaluation. In following the scope outlined in the guidance, EPA has relied on the documents produced prior to and during the mediation. These documents can be viewed as working documents, produced by PRPs, EPA, Maine DEP, the technical consultant of the McKin Superfund Site Community Advisory Group, (SAG), and USGS. As working documents, they did not undergo the normal review associated with submittal of documents for agency approval, but rather evolved as components in the iterative process as the Site conceptual model was refined.

Some documents, such as the regression graphs of groundwater and surface water data (Administrative Record ref # 6596) were a joint effort of all parties. Others, such as the Gray Depot investigation (AR #6249) and the Royal River Discharge Zone investigations (AR #6404 and 8457) present the results of independent field work. And still others, such as GEI's revised Chapter 3 (AR #6594) and SME's conceptual model updates (AR #6403 and 6600-02) were developed by the PRPs in response to mediation discussions and EPA's and Maine DEP's request for a written presentation of the PRPs' evolving perspective.

The McKin parties entered into the mediation process following many unsuccessful efforts by the technical representatives of the PRPs, EPA, and Maine DEP to reach consensus on the fate and transport of contaminants from the McKin property to the Royal River and the practicability of restoring the aquifers or containing the plume. These efforts continued in the mediation framework, adding technical representatives from two community groups. As the mediation progressed, the conceptual model of the Site, that is, the synthesis of the geology and hydrogeology with water quality data, permeability, transmissivity, and gradient data acquired from EPA, PRP, and USGS subsurface investigations, and computer modeling results, was continually revised and refined. As a consequence, the estimates of contaminant flow through bedrock and overburden, amount of residual DNAPL, and time frames for achieving groundwater and surface water standards also evolved to the extent that consensus among the technical representatives was finally reached.

Section 1.00 provides background information and history of the Site. Section 2.00 describes the groundwater ARARs for TCE, 1,1-DCE, and VC which would be waived if it is determined that it is technically impracticable to restore the groundwater at the Site.

Section 3.00 identifies the proposed vertical and horizontal extent of the zone over which the TI determination would apply. It includes the vertical and horizontal extent of the groundwater plume based on monitoring data and inferred transport flow paths.

Section 4.00 presents the conceptual model of the Site, including the geology and hydrogeology, the groundwater contamination sources, transport and fate of contaminants, and current and potential receptors.

Section 5.00 evaluates the groundwater restoration potential, including a review of the potential contamination sources and potential remedial technologies for aquifer restoration, contaminant containment, and contaminant mitigation. The time frame analysis for each technology is also presented.

Section 6.00 presents costs estimates for plume containment and for imposing institutional controls on future activities within the TI zone.

Section 7.00 discusses the protectiveness of the proposed remedial option and Section 8.00 provides the summary and conclusions.

1.3 Background

This section provides a brief summary of the Site history, hydrogeology and distributions of VOCs. Detailed descriptions of these topics can be found in the 1985 Record of Decision, Sevee & Maher Engineers, Inc. March 1999 Data Transmittal And Site Conceptual Model Technical Analysis, Tetra Tech NUS August 1999 Draft Feasibility Study, Royal River Discharge Zone, USGS 1999 Distribution of Trichloroethylene and Geologic Controls on Contaminant Pathways near the Royal River, McKin Superfund Site Area, Gray, Maine, and Tetra Tech NUS February 1999 Transmittal Letter of Revised Aquifer Test Analysis. Section 4.00 summarizes this data in a Site conceptual model.

1.31 Background and History

The McKin Superfund Site is located in Gray, Maine (Figure 1). The McKin property is located on Mayall Road in a predominately residential neighborhood. The McKin Site, as defined by the presence of contamination which has spread beyond the property, encompasses approximately 660 acres of commercial, residential, agricultural, and undeveloped properties.

The McKin facility operated from 1965 to September 30, 1977 as a tank cleaning and waste removal business and as a transfer facility for waste oil and industrial process waste. Waste handling facilities included twenty-two above-ground storage tanks. In 1972, the company expanded with the addition of an asphalt-lined lagoon and an incinerator to handle a large volume of oily waste from a oil spill in Casco Bay. A McKin representative estimated the facility processed 100,000 to 200,000 gallons annually. The incinerator was primarily operated for the disposal of oil impregnated refuse from the oil spill and was used for two to three years. Prior to its use as a waste facility, the property was used intermittently as a sand and gravel borrow pit.(1985 Record of Decision)

In 1973 and 1974, local residents began noticing chemical odors and offensive tastes in their well water as well as discoloration of laundry and notified the Town of Gray's Code Enforcement Officer. Over the next few years, health-related complaints were made by nearby residents. Epidemiological studies conducted in 1983 noted a high incidence of miscarriages in the East Gray area but could not determine whether they or other health issues were causally related to the Site because of the relatively small study population. (Maine Department of Human Services, see Administrative Record # for the 1985 ROD)

In the mid-1970s, laboratory analysis of groundwater samples indicated unidentified organic compounds. In 1977 trichloroethylene and 1,1,1-trichloroethane were identified in the samples. On September 30, 1977 the facility was closed by order of the Town of Gray Code Enforcement Officer and in December 1977 the Town issued a clean-up order to the McKin Company. Also in December 1977, sixteen private wells were ordered to be capped and emergency water supplies were brought into the community. In August 1978, affected homes were connected to the public water supply which was extended into the East Gray area to serve these homes.

The following summer Maine Department of Environmental Protection (Maine DEP) removed approximately 33,500 gallons of liquid wastes from the above-ground tanks and began further investigative work. In April 1983 Maine DEP contracted to have all remaining above-ground tanks, barrels, and containers cleaned and removed from the facility and this was completed in September 1983. EPA listed the Site on the National Priorities List on September 8, 1983, designating it formally as a Superfund Site.(1985 ROD)

Maine DEP entered into a Cooperative Agreement with EPA and performed the Remedial Investigation/Feasibility Study (RI/FS), completing the RI in February 1985 and the FS in March 1985. On May 22, 1985, EPA issued the Record of Decision (ROD) which set forth the selected remedy for the Site and the rationale for it. The selected remedy included on-site soil aeration, excavation of contaminated debris and buried drums with off-site disposal, and off-site groundwater extraction and treatment. In extracting groundwater from the surficial aquifer and in the uppermost portion of bedrock, the ROD remedial action objectives were to: (*i*) reduce flow of contaminated groundwater to the bedrock aquifer; (*ii*) actively treat the surficial aquifer; (*iii*) treat a substantial portion of the bedrock aquifer; and (*iv*) restore, within a reasonable time and practical limits, the off-site aquifer to the ROD-established performance standards. The ROD cost estimate for the extraction system was based on twenty-five wells and the time frame for restoration was estimated to take about five years.

During 1986, a group of PRPs voluntarily undertook remedial action to excavate VOC-impacted soil down to the water table and treat this soil at the McKin property to minimize continued migration of VOCs to the groundwater. Approximately 12,000 cubic yards of soil containing solvents and petroleum wastes were excavated and treated by thermal desorption. The treated soil was then stabilized using cement and replaced in the excavation. The property was then sloped, graded, loamed and hydroseeded.(AR #6246)

Following a May 1988 Consent Decree and two amendments to Appendix A (Remedial Action Work Plan), the Settling Parties (those PRPs who signed onto the Consent Decree for the Remedial Action; other PRPs paid a premium and ended their involvement with the Site) conducted a hydrological investigation and a treatability study and designed a groundwater extraction and treatment system (GETS). In 1990 the Settling Parties constructed the four well GETS west of Mayall Road. Start-up of the GETS began in October 1990 and with agency approval, full time operation began in April 1991.

In July 1993, the Settling Parties submitted a report on the viability of expanding the GETS east of Mayall Road. Their groundwater modeling indicated that regardless of the number or location of extraction wells, restoration of the aquifer would take over two hundred years. The Settling Parties concluded that groundwater restoration of the impacted aquifer was not technically practicable.(AR #6242)

As provided in the Consent Decree, the Settling Parties were required to submit an evaluation of the performance of the groundwater remediation system within fifty-six months of operation of the GETS. This evaluation was to address adjustments or modifications that would noticeably improve the system's performance in achieving the groundwater performance standards and otherwise protect public health, welfare and the environment. In late 1995, EPA and Maine DEP agreed to a PRP proposal that they submit a Technical Impracticability Evaluation Report in place of the fifty-six month report. The agencies also agreed to a suspension of the GETS.

In January 1997, following two revisions of the Settling Parties' October 1995 TI Report, EPA recommended to the other signatories to the Consent Decree, Maine DEP and the Settling Parties, that resolution of the issues be attempted through mediation. The parties agreed and EPA contracted for a convening process which identified McKin stakeholders. The stakeholders selected a mediation company in May 1997 and the formal mediation process began the next month. In September 1997, EPA approved an application for a Technical Assistance Grant to a community group comprised of individuals representing various interests within the community and watershed. This group, the McKin Superfund Site Citizens' Advisory Group (SAG), provided an independent voice for the community interests during the mediation as well as independent technical review of documents developed by both Settling Parties and EPA.

Following an unsuccessful attempt to reach resolution in December 1997, in the spring and summer of 1998 EPA performed an investigation of the Royal River Discharge Zone (RRDZ, Figure 4). This investigation was designed to evaluate the technical practicability of intercepting a sufficient portion of the groundwater plume so as to meet the State Surface Water Quality Criteria. Simultaneously, the PRPs' consultant, Sevee & Maher Engineers, Inc., performed an investigation of the overburden in the Gray Depot area (Figure 5) following discovery of TCE in an exploratory well on the north side of Collyer Brook. With the completion of these studies, a mediation committee developed recommendations for an institutional control zone and long-term monitoring plan for groundwater and surface water.

In October 1999, owners of sub-dividable properties within the Institutional Control Zone joined the mediated discussions to work out an allocation for funding the purchase of their water rights. With this resolved, all parties agreed to the framework of a settlement. A Memorandum of Understanding between EPA, Maine DEP, and the PRPs memorializes this consensus.

1.32 Physical Characteristics of the Site

The McKin property comprises an area of approximately 7 acres located on the west side of Mayall Road. The McKin Site includes those areas presently and potentially impacted by groundwater contamination from the McKin property, and is bounded roughly as follows (Figure 6):

> On the south by Yarmouth Road from Depot Road to Mayall Road and a line from the southern terminus of Mayall Road running east to the Royal River;
> On the east by Royal River;
> On the north by Collyer Brook;
> On the west by a line from the intersection of Collyer Brook with Merrill Road and closing at the intersection of Depot Road and Yarmouth Road

Based on observed contaminant distribution, the Site also extends north of Collyer Brook at its confluence with the Royal River, and east just beyond the Royal River at the river bend due east of the McKin property. In total, the Site consists of approximately 660 acres of commercial, residential, agricultural, and undeveloped properties.

The topography west of the McKin property is relatively flat. The topography of the property has been modified by past excavations, and is fenced. The property is accessible from Mayall Road. East of Mayall Road, the land slopes downward to the flood plain of the Royal River. The land surface is dissected by a number of small, unnamed streams, and associated gullies. The resulting topography is frequently very steep, and access can be difficult.

The RRDZ is the area of the Site where the TCE groundwater plume discharges to the Royal River, approximately 3,700 feet west of the McKin property on Mayall Road and 1,500 feet south of Depot Road. The Royal River flows generally south through the study area. At the southern end of the RRDZ, it turns east for approximately 1,200 feet, flowing under the Maine Central Railroad bridge before turning south again.

The Royal River empties into Casco Bay in the Town of Yarmouth, Maine. The river flows a distance of 25 miles from its source to Casco Bay and has a total drainage area of 142 square miles. The drainage area of the Royal River upstream of the study area is approximately 70 square miles.

The elevation of the Royal River in the RRDZ is approximately 200 feet lower than the McKin property. Within the RRDZ area the river channel is approximately 45 to 60 feet across. The riverbanks are steep and have a moderate to dense sapling and shrub cover, with trunks and branches outstretched over the river. The canopy over the river is frequently open. The flood plain in the RRDZ is a relatively level terrace, 70 to 100 feet wide, behind the steep banks of the river channel. Flooding in the area appears to occur during the winter and early spring months as a result of heavy rainfall on snow-covered or frozen ground. Flooding in the summer months is most often associated with prolonged heavy rainfall or tropical storms. Wetland areas are located in the Royal River flood plain, typically situated in eroded channels and depressions on the flood plain terrace draining to the river. Topography rises steeply west of the flood plain and terrain consists of a series of irregular, steeply sloped hills, as much as 50 feet higher than the flood plain.(AR #8457)

1.33 Distribution of Contaminants of Concern

Historical disposal of liquid VOCs at the McKin property has led to contamination of the underlying unsaturated soils, groundwater in the saturated soils and bedrock, and in the Royal River. The primary Contaminant of Concern is trichloroethylene (TCE), with cis-1,2-dichloroethene (DCE) and 1,1,1-trichloroethane (TCA) also present at much lower concentrations and at fewer locations. Vinyl chloride was detected in a groundwater seep in the Royal River flood plain.

<u>Soils</u>

From July 1986 to February 1987, approximately 9,500 cubic yards of VOC- contaminated soil from five locations and the lagoon were excavated. The excavations ranged from five to forty-two feet below the ground surface, stopping either when the performance standard had been reached or the water table was reached. These soils were processed through a low temperature thermal aeration system in an enclosed environment. Following sampling which demonstrated that the Record of Decision performance standard of 0.1 mg/kg (or 0.1 ppm) for TCE had been attained, the soils were mixed with water and cement and backfilled. Excavation continued outward toward the property perimeter until TCE concentrations were below 1.0 ppm.

From November 1986 to April 1987, approximately 2,500 cubic yards of petroleum-contaminated soil from four locations were excavated and similarly treated, sampled, and backfilled. Final perimeter sampling of the excavations indicated concentrations were less than 1.0 ppm of polycyclic aromatic hydrocarbons and total extractable hydrocarbons.

See Canonie, AR #6246 for further information on the soil treatment.

<u>Overburden Groundwater</u>

As liquid waste from the property contaminated the soils beneath the property, it migrated through the unsaturated soils to the overburden groundwater. Based on contaminant concentrations measured in the excavated soils, it is believed that the waste migrated to the water table as a free-phase, dense, non-aqueous phase liquid (DNAPL). Once in the groundwater, the DNAPL continued to spread, until it became bound up by the finer grained silts in the soil or in fractures in the bedrock., and it no longer flowed as a liquid under the normal hydraulic gradients present at the Site. At this point, it is termed residual DNAPL, and it continues to act as a long-term source of VOCs by slowly dissolving into the ambient groundwater.

Groundwater that has come into contact with residual DNAPLs has created a plume of dissolved VOCs which has spread from the McKin property to the north and east (Figure 2). The overburden pathway for the plume is not precisely known, that is to say, it is not known whether there is a continuous overburden plume extending to Collyer Brook from the McKin property nor has a centerline of the overburden pathway been identified in the portion of the Royal River plume. It is inferred from residential bedrock well water quality, monitoring well data, and measurement of vertical gradients that groundwater flows from overburden to bedrock, and then further from the McKin property, back into the overburden. Nonetheless, for the purposes of this TI evaluation, the overburden plume is considered to be present as noted in Figure 2.

See SME Quarterly Report, August 2000, (AR#8456) for compilation of the overburden groundwater data.

<u>Bedrock Groundwater</u>

Residential wells downgradient of the McKin property were found to be contaminated with TCE in the 1970s. These wells ranged in total depth from 70 to 660 feet. Depth to competent bedrock, assuming the well casing was installed through the overburden soils and the more heavily fractured upper bedrock, ranged from 37 to 200 feet. Penetration into the competent bedrock, derived by assuming it equals the total well depth minus the casing length ranged from 30 to 440 feet. These wells are noted in Table 1 and Figure 7. (AR #6504)

The 1985 Record of Decision set as an remedial action objective the restoration of the off-site aquifer, within a reasonable time and practical limits. This was to be accomplished by extracting groundwater from the overburden aquifer and in the uppermost portion of bedrock, with the expectation that the groundwater extraction system would reduce flow of contaminated groundwater to the bedrock aquifer and treat a substantial portion of the bedrock aquifer. Systematic recovery of contaminated groundwater from the fractured bedrock to clean the bedrock aquifer was deemed to be technically infeasible. Consequently, further investigation of the deep bedrock, which had served as the drinking water source for the area, was not performed and therefore there is no current data to establish the extent of contamination in the deep bedrock. Indirect evidence, again such as the groundwater gradient data, the presence of TCE at one location in the overburden at the confluence of the Royal River and Collyer Brook without any other overburden locations, as well as mass flux calculations, combined with the direct overburden and shallow bedrock data, provide sufficient comfort to view the bedrock plume as generally the same as the overburden plume.

See **Hart 1978,** (1985 ROD AR #missing), Gerber 1982 (AR #6239) for results of residential wells and SME August 2000 (AR #8456) for results in the shallow bedrock monitoring wells.

Surface Water

As part of the monitoring program for the McKin Site, surface water has been collected for chemical analysis on a regular basis since 1989 from Collyer Brook, Royal River, and Boiling Springs. Additional sampling was performed in 1997 to further delineate the discharge of contaminants to the river and to determine the downstream extent of the measurable concentrations. (Figure 8 for sampling locations).(AR #6607)

Samples from Collyer Brook have not indicated the presence of TCE other than a couple sporadic and non-reproducible detections.

TCE enters the Royal River from groundwater seeps into the river bottom and from runoff from Boiling Springs. The 1997 USGS sampling identified a zone of approximately 800 feet where TCE-contaminated groundwater is discharging into the river (Figure 9). Within the 800 feet, the discharge is concentrated near the confluence of the unnamed stream and the bend in the Royal River. The SME 1997 downstream sampling detected low levels of TCE as far downstream as Yarmouth, a distance just under twelve miles. Sampling by the SME and USGS/EPA has not detected TCE at any other surface water springs either in the flood plain or further upgradient in any of the gullies or ephemeral streams. (AR #6254 and 6607)

Data from the previous sampling efforts and the RRDZ field investigation were used to identify the Contaminants of Concern (COCs) in the Royal River and Boiling Springs. The COCs for surface water are those contaminants that exceed chemical-specific ARARs, i.e., federal or state drinking water or surface water quality standards. The Royal River is not currently used as a drinking water source, however based on surface water characterization data, the level of TCE in the Royal River consistently exceeds the Maine standards for Class B water prohibiting TCE in excess of 2.7 ppb (μg/L) (based on human health for consumption of water and organisms). In addition, the level of TCE in Boiling Springs, a potential drinking water source, exceeds the federal MCL of 5 μg/L, which is a primary drinking water standard.

See SME August 2000 (AR #8456) for the compilation of surface water data.

2.00 Site-Specific Applicable or Relevant and Appropriate Requirements (ARARS)

Section 300.430 (e) of the National Contingency Plan (NCP) requires that on-site remedial actions at CERCLA sites must meet ARARs under federal or state environmental or facility siting laws unless there are grounds for invoking a waiver. A waiver is required if ARARs cannot be achieved. Other federal and state advisories, criteria, or guidance, as appropriate (to be considered – TBCs), should be considered in formulating the remedial action.

ARARs are promulgated, enforceable federal and state environmental or public health requirements. There are two categories of requirements: "applicable" and "relevant and appropriate". CERCLA does not allow a regulation to be considered as both "applicable" and "relevant and appropriate". These categories are defined below:

Applicable Requirements - Section 300.5 of the NCP defines applicable requirements as "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site".

Relevant and Appropriate Requirements - Section 300.5 of the NCP defines relevant and appropriate requirements as "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site."

To be considered (TBCs) guidelines are non-promulgated criteria, advisories, and guidance issued by the federal or state governments. Along with ARARs, TBCs may be used to develop the interim action limits necessary to protect human health and the environment.

ARARs and TBCs are divided into three categories: chemical-specific, location-specific, and action-specific. In Sections 2.1.1 through 2.1.3, these categories are briefly described, and those for which a technical impracticability waiver is sought are identified.

2.1.1 Chemical-Specific ARARs

Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the determination of numerical values that establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. In general, chemical-specific requirements are set for a single chemical or a closely related group of chemicals. These requirements do not consider the mixture of chemicals. A summary of chemical specific ARARs is presented in Table 2.

The Maine Water Classification Program sets standards for the classification of state waters. The Royal River is a Class B river/stream and Maine standards for Class B water prohibit discharge of TCE in excess of 2.7 ppb (μg/L) based on human health for consumption of water and organisms. The state water quality standard may be used to establish relevant and appropriate requirements in establishing surface water remediation goals for the McKin Site RRDZ.

The federal Maximum Contaminant Levels (MCLs) are chemical-specific ARARs that govern the quality of drinking water provided by a public water supply. MCLs may be used as relevant and appropriate requirements in establishing groundwater remediation goals and surface water remediation goals for Boiling Springs.

The state Maximum Exposure Guidelines (MEGs) are chemical-specific ARARs that are health-based guidelines intended to determine drinking water quality for private residential wells. MEGs may be used as relevant and appropriate requirements in establishing groundwater remediation goals and surface water remediation goals for Boiling Springs.

The MCLs and MEGs for which a technical impracticability waiver will apply are as follows:

Contaminant of Concern	**1999 Maximum Groundwater Concentration (ppb) and Location**	**MCL**	**1992 MEG**	**1985 ROD Performance Standard**
trichloroethylene	3,200 - MW-206A	5	5	28 ppb
1,1,1-trichloroethane	94 - MW-206A	200	200	92 ppb
cis-1,2-dichloroethene	42 - MW-206A	70	70	no ROD standard
1,1-dichloroethene	1.1 - B-1A	7	7	no ROD standard
tetrechloroethene	2.3 - B-1B	5	5	no ROD standard
vinyl chloride	non-detect at all monitoring locations. Detection limit varies with location	2	0.15	no ROD standard

2.1.2 Location-Specific ARARs

Location-specific ARARs are restrictions placed on the concentrations of hazardous substances, or the conduct of activities solely because they are in specific areas. The general types of location-specific ARARs that may be applied to the McKin Site are briefly described below and are presented in Table 3.

Several federal and state ARARs regulate activities that may be conducted in wetlands and flood plains. These regulations and requirements may apply because the boundary of the 100-year flood plain encompasses the level terrace behind the steep banks on the Royal River's channel. Wetlands are situated in eroded channels and depressions on the flood plain terrace. The Wetlands Executive Order (E.O. 11990) and the Flood Plains Executive Order (E.O. 11988), incorporated into 40 CFR

Part 6, Appendix A, require that wetlands and flood plains be protected and preserved, and that adverse impacts be minimized. Section 404 of the Clean Water Act and State wetland protection regulations restrict activities that adversely affect wetlands and waterways. The RCRA location standards outline the requirements for construction of a RCRA facility located in a 100-year flood plain.

Additional location-specific ARARs include the Fish and Wildlife Coordination Act, which requires that any federal agency proposing to modify a wetland or body of water must consult with the U.S. Fish and Wildlife Service. Regulations governing endangered species at the federal and state levels would need to be considered for any proposed on-site actions. Regulations governing historical and archeological resources would need to be considered should such resources be encountered during the remedial action.

The Maine Natural Resources Protection Act governs activities that may occur in or adjacent to wetlands or surface water bodies. The Maine Site Location Development Law regulates activities that may adversely affect existing land uses, and scenic character or natural resources, and needs to be considered in the alternatives implementation.

No waiver of location-specific ARARs is being sought for the McKin technical impracticability evaluation. Location-specific ARARs are being met during the Boiling Springs pilot study being conducted by EPA during the summer, 2000.

2.1.3 Action-Specific ARARs

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are generally focused on actions taken to remediate, handle, treat, transport, or dispose of hazardous wastes. These action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be implemented. The general types of action-specific ARARs that may be applied to the McKin Site are briefly described below and are presented in Table 4.

Potential action-specific ARARs include federal and state criteria that may be applied as action levels for surface water response actions. For example, ambient air quality standards may be applied to actions that could result in air emissions of specific VOCs.

A number of RCRA regulations govern emissions from process vents, equipment, tanks, and containers. These requirements may be considered depending on the response actions selected. The Clean Air Act's National Emission Standards for vinyl chloride would need to be considered for actions that could release this VOC to the ambient air.

The Maine Hazardous Waste Management Rules regulate treating, storing, and disposing of hazardous wastes. Other state regulations that govern solid waste, particulate emissions, discharges that affect surface water quality, and air pollution may need to be considered.

No waiver of action-specific ARARs is sought for the McKin Site technical impracticability evaluation.

3.0 Spatial Extent of the Technical Impracticability Zone

This section describes the proposed horizontal and vertical extent over which the Technical Impracticability decision would apply (TI Zone). This includes the portion of groundwater known to contain VOCs above federal MCLs that would require substantial time frames to remediate using currently available technologies, as well as areas where VOC contamination above MCLs is inferred (bedrock aquifer). Section 5.5 provides the estimated cleanup time frames for groundwater containing VOCs.

The proposed TI Zone covers horizontally the same area designated as the Institutional Control Zone and vertically, extends to the deep bedrock. The proposed TI Zone includes the McKin property, extends to the west past Depot Road, north to Collyer Brook along Merrill Road, east to the Royal River and immediately beyond it, and south to Yarmouth Road from the intersection with Mayall Road to the intersection with Depot Road. (See the ICZ on Figure 6) The TI Zone as described is intended to include all areas where contamination is present as well as areas where it may be present or may be induced to flow to by pumping. Once these areas were identified, the boundaries of the TI Zone were then adjusted as much as possible to match geographic locations and current property boundaries.

The presence of TCE in the overburden north of Collyer Brook, near the confluence with the Royal River, led to the expansion of the TI Zone beyond Collyer Brook for one parcel of property. An overburden investigation of properties west of this area and along both banks of Collyer Brook up to Merrill Road did not detect any VOCs on these properties. However, because the extent of dissolved TCE in the bedrock is not known, EPA can not rule out the possibility that it could be induced by pumping. Therefore the technical sub-committee of the McKin mediation effort, comprised of representatives of all parties involved in the Site, identified them as properties which should have restrictions preventing the installation of water wells. The whole mediation group, however, decided that this could be accomplished through the use of conservation easements rather than inclusion in the TI Zone.

The TI Zone does not include the Royal River or Collyer Brook.

4.0 Site Conceptual Model

This section presents a conceptual model of the McKin Site, including the site geology and hydrogeology, the nature and extent of Contaminants Of Concern in soil and groundwater, fate and transport processes, and current or potential receptors. This conceptual model has been developed through review of reports of previous investigations and previous conceptual models. As may be expected for a site with an extensive history of analytical data and computer modeling, the conceptual model developed for the Site has evolved through several iterations. The current model should be seen therefore as a continuing refinement of previous models, reflecting the analytical data and subsurface investigations. It forms the basis for evaluating potential remedial actions.

4.1 Site Geology and Hydrogeology

The site geology and hydrogeology have been described in detail in previous reports produced by consulting firms for Maine DEP, the PRPs, and EPA. A summary of the site geology and hydrogeology is provided below.

4.1.1 Site Geology

Surficial Materials

The surficial materials present at the McKin Site include coarse-grained glaciomarine deposits, fine-grained glaciomarine deposits, flood plain alluvium, and glacial till (Figure 10).

The McKin property is located near the eastern edge of the East Gray glaciomarine delta, which forms a relatively flat surface north, west and south of the property. The delta is composed of layered sand and gravel that can be seen in the gravel pit excavations west of Depot Road. These well to poorly sorted gravel, sand, and local diamict sediment (silt and clay size) were laid down as deltaic and subaqueous fan deposits in contact with the glacier margin during retreat of the ice sheet in the glacial sea. Logs of wells and test borings at the McKin property indicate that the coarsest grained delta deposits lie north-northeast of the site.

Moving east from the McKin property toward the Royal River, the sediments are finer grained, better sorted, and beds generally dip southerly farther from the ice-margin position. In distal parts of the deposits, fan and delta sediments interfinger with fine-grained glaciomarine sediments.

The fine-grained glaciomarine sediments (Presumpscot Formation) are present at land surface in most places at and below 240 feet elevation east of the McKin property. This elevation occurs about 1000 feet east of Mayall Road and roughly parallels it from Route 115 to the intersection with Depot Road. These sediments consist of massive to finely laminated, gray to dark-bluish gray silt, clay, and minor fine sand that locally interfingers with the coarse-grained deposits, but mostly overlies it (deposited after the coarse-grain). The glaciomarine silts and clays range in thickness from a few feet to more than 100 feet (Figure 11).

The irregular land surface of the fine-grained sediments is the result of erosion and downcutting in postglacial time by the Royal River, Collyer Brook, and the many tributary streams and seasonal stream gullies. In some places, postglacial streams have cut through the entire thickness of the fine-grained sediments, leaving coarse-grained materials at or near the surface.

The flood-plain alluvium consists of silt, sand and gravel, and variable amount of organic material. These materials are present on the flood plains of the Royal River, Collyer Brook, and the unnamed tributary entering the Royal River from the west about 350 feet upstream from the railroad trestle. The alluvial deposits are 10-12 feet thick along the Royal River, and thinner along the smaller streams. It overlies glacier material in most locations.

The glacial till lies between the coarse-grained glaciomarine sediments and the bedrock. It is nonsorted and nonstratified, a compact mixture ranging from clay to large boulders, with a matrix of fine sand containing up to twenty-five percent silt and clay. The till is absent in places and is typically less than twenty feet in thickness when present. (AR #6254, 6601, and 8457)

Bedrock

The surficial material are underlain by granitic bedrock of the Sebago pluton. The bedrock surface lies at depths of 50 to 100 feet beneath the eastern edge of the glaciomarine delta and slopes eastward toward the Royal River to a depth of nearly 200 feet beneath surficial materials.

The Sebago Pluton has been mapped by the Maine Geological Survey beneath surficial deposits at the McKin site. According to the Bedrock Geology of the Gray 7.5-minute Quadrangle, Maine (Creasy and Robinson, 1997), the Sebago Pluton beneath the site and surrounding areas is classified as a muscovite-biotite granite. It consists of white to pink, medium-grained muscovite-biotite granite. The biotite is finer grained (2-3 mm) and the muscovite coarser grained (5 mm). Both are present in equal amounts. Muscovite-biotite pegmatite are present as crosscutting dikes with muscovite-biotite granite, muscovite-garnet granite, and metamorphic lithologies. (AR #8457)

The bedrock is fractured in various directions. According to Creasy and Robinson, data suggest steeply dipping foliation with various strike directions. Major joint sets strike in a northeast direction and two minor joint sets strike in northwest and north-northwest directions. These fracture orientations are consistent with linear features reported in Photo-lineament Mapping at 1:40,000 Scale in the Sebago batholith and Bottle Lake Complex of Maine (Caswell, Eichler and Hill, Inc., 1990). In this report, the most common lineament direction, based on the maxima of 17,025 photo-lineaments mapped in the Sebago batholith, are west-northwest and northeast, while the less common trends are north-northwest and east-northeast. A series of north-northwest striking photolinear segments are mapped crossing the McKin property and continue both north and south of the site. Moreover, east of the site, an east-northeast photolinear feature extends to the Royal River and a series of east-west photolinear features intersect or cross the Royal River between Collyer Brook to the north and the Unnamed Stream to the south. While these photolinear features have not been ground-truthed, their directions are parallel with the strike of bedrock fractures. The detection of TCE at GWD-2 (6.3 to 13 ug/L) in the Gray Depot area suggests groundwater transport via bedrock fractures in a east-northeast direction from the McKin property.

Two bedrock troughs have been identified from geophsical data: a trough that trends in a southeasterly direction from the junction of Mayall and Depot Roads towards the Royal River; and a trough located west of the Royal River and trending in a southerly direction. The bedrock troughs are expected to have higher transmissivity due to the increased thickness of the saturated surficial materials and enhanced bedrock fracturing. (AR #6254, 6601, and 8457)

4.1.2 Site Hydrogeology

Groundwater Flow

A potentiometric surface map of the McKin site to the Royal River and surrounding areas is shown on Figure 12. Groundwater is recharged by infiltration of precipitation above an elevation of 240 feet and by leakage from the Presumpscot Formation. The direction of groundwater flow is generally from west to east toward the Royal River. Vertical upward gradients along the Royal River, and the presence of contaminants in the river that are the same as those in the groundwater plume indicate groundwater from the site discharges to the Royal River.

Groundwater in the area of the McKin property flows northwardly toward the intersection of Mayall and Depot Roads. Most of the flow then turns eastward toward the Royal River with the remainder of flow continuing north-northeasterly toward Collyer Brook. Groundwater flow is driven by the approximately 200-foot elevation difference between the McKin property and the Royal River and Collyer Brook. Detailed directions of groundwater flow in both the overburden and fractured bedrock are uncertain due to the heterogeneity of the deposits and the location, orientation, and extent of the bedrock fractures.

An unnamed tributary, which begins approximately 600 feet east of the McKin property, flows perennially for over a thousand feet to its confluence with the Royal River. The confluence is just upstream from the river's eastward bend in the discharge zone. Because the altitude of this stream, as determined by the topographic contours, is above the potentiometric surface of the overburden aquifer, perennial flow is most likely derived from groundwater seeps from silts and fine sands of the Presumpscot Formation. Analysis of vapor-diffusion samples placed in this tributary did not detect any VOCs, further indicating it is not hydraulically connected with the coarse-grain glaciomarine deposits.

The Royal River is presumed to form the downgradient boundary of the regional aquifer system. In this area, upward hydraulic gradients are present where groundwater flow from both the east and west sides of the river converges. The actual boundary is a conceptual surface where the two lateral flows meet, roughly defined by the river position. There will also be some mixing of contaminants across this boundary due to diffusive and dispersive fluxes.

Paired monitoring wells installed in the overburden and the underlying shallow bedrock indicate downward hydraulic gradients from the overburden into the bedrock at the higher topographic elevations. At the lower elevations of the Site, vertical gradients are upward from the bedrock into the overburden. These gradients provide the driving force to transport groundwater and VOCs away from the McKin property downward into the coarse-grained glaciomarine deposits and bedrock and then back up into the overburden in the bedrock trough and flood plain of the Royal River.

The primary hydrostratigraphic unit of the surficial aquifer consists of sand and sand-gravel deposits. The hydraulic gradients are controlled by the transmissivity (saturated thickness times the hydraulic conductivity) of the units and the elevation of the river. As shown by Figure 11, west of B-4A, the surficial aquifer consists of predominately fine to coarse sand that ranges from 0 to 45 feet in saturated thickness. East of B-4A, the saturated thickness increases to as much as 185 feet in the buried valley and the materials become coarser, which increases the transmissivity and causes the hydraulic gradient to be flatter in the vicinity of the bedrock valley, and continues to be flat to the regional discharge area along the Royal River. The vertical hydraulic gradients are downward over most of the Site except along the Royal River where vertical gradients are upward. Recent studies show that groundwater in the surficial aquifer downgradient from the McKin Site discharges through a narrow reach of the Royal River where the Presumpscot Formation is thin or has been incised by coarse river alluvial sediments that are in contact with coarse-grained glaciofluvial deposits. The location of this narrow reach occurs between Boiling Springs and the railroad bridge.

The overburden aquifer is unconfined in the area from south and west of the McKin property to about 1000 feet east of Mayall Road where the coarse-grained glaciomarine sediments are at the surface. The saturated thickness in these sediments ranges from a few feet to about forty feet. Near the McKin property the saturated thickness of the overburden aquifer is generally less than fifteen feet. Hydraulic gradients are steep in this area and the water table approximately parallels the steeply sloping bedrock surface.

Moving east toward the river where the Presumpscot Formation (fine-grained glaciomarine sediments) overlies the coarse-grained sediments, the groundwater in these coarse-grained sediments is confined by the silt and clay of the Presumpscot Formation. The hydraulic gradients decrease from about 0.1 ft/ft to about 0.003 ft/ft in the confined part of the aquifer. The change in gradient is attributed mainly to increased transmissivity caused by the increased aquifer thickness in the area of the buried bedrock trough. The potentiometric low is present at the confluence of the unnamed tributary and the Royal River. Boiling Springs, located in the flood plain west of the river, and sand boils present in the river upstream from the unnamed tributary are the surface expression of the groundwater. The overburden aquifer returns to unconfined or semi-confined conditions in the flood plain where the Presumpscot Formation has been eroded away.

Recent studies show the flood plain along the RRDZ is underlain by river alluvium. The alluvium consists of two separate facies. The upper facies in the RRDZ area consist of three to ten feet of predominately silt to fine sand with widely disseminated organic materials. The lower facies consist of two to five feet of coarse sand and fine gravel with interbedded fine to medium sand, and medium to coarse sand. This facies also contains plant fragments such as twigs, bark, pine cones, and finely disseminated organic fragments. (Figure 13)

Most of the groundwater contamination in the RRDZ study area occurs within the coarse-grained glaciomarine sand and sand and gravel deposits. Groundwater contamination also occurs in the lower, saturated portion of the Presumpscot Formation. Contaminated groundwater can migrate through interconnected sand lenses within the Presumpscot Formation and the river alluvium beneath the flood plain of the Royal River.

The low-permeability deposits of the upper alluvium contain lenses of fine sand that are believed to be interconnected with the sand and gravel aquifer, allowing contaminants to migrate to surface water seeps and Boiling Springs along the west bank of the Royal River flood plain. Boils also occur in the riverbed along the west bank of the Royal River where the fine-grained alluvial sediments are thin or absent. (AR #6254, 6601, and 8457)

Aquifer Characteristics

Laboratory analysis, in situ slug tests, and pumping tests produced a range of horizontal hydraulic conductivity values for the coarse-grained overburden deposits from ten to fifty feet/day. Vertical hydraulic conductivity is estimated to be ten to fifty times lower than the horizontal. The average bedrock hydraulic conductivity was calculated at about 0.07 ft/day.

In situ density testing and by saturated soil water content testing indicated the total porosity of the overburden aquifer ranged from 0.27 to 0.45 with an average of 0.36. The average TCE soil distribution coefficient (K_d) was calculated from batch studies to be 0.28 mL/gm. Using this value, a retardation coefficient of 2.3 was calculated.(AR #6601)

Additional analysis of the RRDZ investigation determined the transmissivity of the surficial aquifer ranged from 14,740 ft^2/day to 15,810 ft^2/day and storativity ranged from 0.001 to 0.003 based on Neuman's method, which accounts for delayed drainage from alluvial sediments in the upper portion of the aquifer. The hydraulic conductivity at the RRDZ is calculated to be 170 ft/day at MW-1 where the saturated thickness was determined to be 87 feet. In addition, the vertical hydraulic conductivity is 61.8 ft/day. Additional details are provided in Appendix G in AR #8457.

Water Budget

Based on the RRDZ investigation, approximately 295 gpm of contaminated groundwater discharge to the river from the Site. The calculations are presented in Appendix H of AR #8457. It was previously estimated that between 180 to 270 gpm of contaminated groundwater was discharged to the river system from the Site with approximately one-third discharging to Collyer Brook, and the remaining two-thirds discharging to the Royal River (SME, 1989). Boiling Springs discharges 45 gpm to the Royal River and the unnamed stream discharges about 450 gpm (AR #6601). Most of the contaminated groundwater from the sand and gravel aquifer passes through the RRDZ . In addition, the overburden in the RRDZ receives flow from the bedrock aquifer that has not been quantified because there are no bedrock wells where the contaminant plume discharges into the overburden.(AR #8457)

4.2 Nature and Extent of Contaminants in Groundwater and Surface Water

VOCs in groundwater and surface water originated from the disposal of liquid VOCs at the McKin property. Groundwater carrying dissolved VOCs has spread from the McKin property, creating overburden and bedrock plumes which extend to Collyer Brook and the Royal River. The plume was initially characterized as a single plume which spread north from the McKin property toward the intersection of Mayall and Depot roads and then turned to the east toward the Royal River and to the northeast toward the lower reach of Collyer Brook. (AR #6239) As monitoring locations were added and information gained on the bedrock surface and amount of saturated overburden, the overburden plume was understood to be two separate plumes. The divergence occurs south of the Mayall and Depot intersection with a bedrock knoll splitting the overburden flow into the two separate plumes. Limited sampling of surface water springs and ponds in the area between the two plumes have never detected any contaminants.

The shape of the bedrock plume is expected to be similar to the overburden plume, particularly at the perimeter. However, as flow through the bedrock is controlled by fractures in addition to gradient, it is possible that the bedrock plume may be contiguous beneath the overburden rather than separating into two plumes. The absence of overburden contamination between the two overburden plumes, in addition to the attributed bifurcation of groundwater flow by the bedrock knoll, may also reflect the downward gradient in the area. Consequently, contamination within the bedrock would not discharge into the overburden in this area. Without further exploration of both overburden and bedrock in this inter-plume area, the shape of the bedrock plume in this area can not be determined.(AR #6254)

4.21 Migration of VOCs toward Collyer Brook

As depicted in Figure 2, a plume originating at the McKin property has extended northerly to Depot Road. VOCs, primarily TCE, have been detected in overburden monitoring wells B-1B, B-2B, B-2C, and B-5B since sampling began in 1984. Following the direction of groundwater flow, TCE has been detected north of Mayall Road at Mitchell Spring and MW-203B. Recent investigation of the overburden adjacent to the lower reach of Collyer Brook found TCE at GWD-2 but not at the other sampling locations (Figure 14).(AR #6249)

Sampling of the bedrock monitoring wells paired with the above overburden monitoring wells, B-1A, B-2A, B-5A, and MW-202A has also detected VOCs since their installation. As noted above in Section 1.33, TCE was detected in residential bedrock drinking water wells north and northeast of the McKin facility.

Because of the relatively few monitoring locations within this northern plume, the location where the hydraulic vertical gradient changes from a recharge to discharge condition is not known. Review of the available data indicates there is still a downward component of flow at the B-5 well cluster. At the MW-203 well cluster, the hydraulic vertical gradient fluctuates, possibly in reaction to seasonal precipitation fluctuations.

Collyer Brook is presumed to form the downgradient boundary of the groundwater system. In this area, it is expected that groundwater flows from both sides to Collyer Brook (south, from the McKin property side, north, from the Mountain Road side), meets beneath Collyer Brook and discharges into it. The presence of TCE at GWD-2 on the north side suggests that the actual boundary shifts and therefore Collyer Brook should not be considered a groundwater barrier. Another possible explanation may be that the Royal River exerts a greater hydraulic control and is the groundwater boundary in the Gray Depot area. (AR #6249)

4.22 Migration toward Royal River

The configuration of the bedrock surface serves as a major control on groundwater flow patterns Figure 15). As noted above, subsurface investigations identified a bedrock knoll near the intersection of Mayall and Depot Roads. This has created an area of limited saturation in the overburden and in effect has acted as a wedge separating the overburden plume. Similar to the northern plume, the eastern plume moving to the Royal River has had detected VOCs, primarily TCE, in the overburden wells MW-212C, B-3B, B-4A, and B-102 and SW-5 (Boiling Springs) since sampling began in the mid-1980s.

The centerline of the eastern plume appears to follow the identified bedrock trough which begins on the south side of the bedrock knoll and trends easterly 400 - 500 feet toward the Royal River. As this trough plays out, the plume widens as it continues toward the river, following the direction of groundwater flow. Approximately 400 - 500 feet further east, the plume enters a steeply sloping bedrock trough, this one trending south. This zone of increased transmissivity flattens out the gradient as the plume approaches the Royal River. The overburden plume discharges from this trough through the flood plain alluvium into the Royal River.(AR #6254)

4.3 Fate and Transport Processes

Much of the contention regarding the Site conceptual model focused on the transport of the contamination from the facility to the Royal River. GEI calculated the mass of TCE discharging into the Royal River. To derive this mass, GEI used water quality data from the 800-series monitoring wells located in the southerly trending trough and the estimated groundwater flux through the overburden (based on annual rainfall amounts and infiltration rates for the various geologic units). As this calculated amount was less than the actual amount (it itself a calculation of water quality data and river gaging data), GEI deduced that the remainder must come directly from the bedrock into the river. (AR # 6758)

EPA and Maine DEP agreed that contamination had entered the bedrock near the Site - the contamination of the residential wells demonstrated the flow of contaminants into the bedrock. With limited vertical gradient data in the 3,200 feet from Mayall Road to the Royal River, it is uncertain whether TCE detected in the overburden represents flow only through the overburden or may reflect a combination of overburden flow and seepage from bedrock. Regardless of the interaction between bedrock and overburden between Mayall Road and the southerly trending trough, the agencies favored a conceptual model which had the contamination in the bedrock discharging into the coarse glaciomarine deposits in the trough. If this was a more accurate representation of Site conditions, the TCE-contaminated groundwater could be intercepted prior to its discharge into the river.

The technical representatives concurred there were insufficient data to conclusively support one model over the other. Water quality data from the microwells installed in the flood plain during the 1998 Tetra Tech NUS investigation showed that the highest concentrations were in a zone 15 to 60 feet below the surface. Yet the study also showed contamination was present all the way down to the bedrock surface at 100 feet below the surface (Figure 16).(AR #8457)

As part of the assessment on the fate of the TCE during its movement from the facility to its surface water discharge area, SME evaluated the potential degradation of TCE in the overburden. The dissolved oxygen, E_H, metals, and methane data indicated that mildly reducing redox conditions exist and therefore reductive dechlorination of TCE was limited. It was noted that biodegradation may have played a larger role early in the site history as the chlorinated solvents were commingled with petroleum waste which produced a carbon source to naturally-occurring microbes. (AR #6601)

EPA reviewed the cis-1,2-dichloroethylene (DCE) data collected from May 1996 to the present (prior to May 1996, only total DCE data was reported) to assess its extent and whether the concentrations were increasing as TCE concentrations were decreasing. DCE was present in fourteen wells, or about one-third of the wells sampled. At all locations, DCE is decreasing. In some wells, such as the MW-803 cluster, there appears to be a downward cyclical pattern. At MW-206A and B, the decrease appears to be slower. Of note is that at MW-401C and MW-403C, both installed on the facility, and at MW-801B and C, installed at the southern edge of the plume near the Royal River, concentrations have dropped below 2 ppb. Therefore EPA concluded that degradation of TCE to DCE is minimal and unlikely to create additional risk.

In addition, EPA reviewed the vinyl chloride groundwater data. Vinyl chloride has not been detected in any of the monitoring wells. It is noted that in some locations, because of dilution necessary to measure the higher TCE concentrations, the detection limit for vinyl chloride is elevated. Yet for those wells with a detection level of 1 ppb, vinyl chloride is not detected.

Vinyl chloride was detected in one of six groundwater seeps at the edge of the Royal River during the FFS. It is believed that biodegradation of TCE occurred in the relatively rich organic soil present in the flood plain. As this organic soil is limited both horizontally and vertically, EPA EPA therefore concluded that degradation of TCE to vinyl chloride is minimal and unlikely to create additional risk.

4.4 Current or Potential Receptors

Human health and environmental risk assessments were conducted as part of the Feasibility Study leading up to the 1985 Record of Decision. These assessments identified current and potential future receptors and evaluated the risks posed by the Site contaminants. The ROD stated that the current human receptors included persons coming in contact with on-site soils and recreational users of the Royal River. Two potential future receptors were identified: workers/ public to inhalation exposure from soil remediation activities; and residential well water use (this was considered potential because at the time of the risk assessment, there were no known users of the groundwater as a drinking water supply following the extension of the municipal water lines). Of these current and potential receptors, unacceptable risk was only associated with future residential well water use as engineering controls would be expected to maintain contaminants below ambient air levels during the soil remediation.

The environmental risk assessment identified aquatic species in the Royal River as current and future receptors and concluded that there was not a significant risk associated with the observed concentrations of contaminants. The ROD also noted the contaminated aquifer as a loss of an environmental resource which would be inadequately protected by a No Action Alternative.

As part of the review of the evaluation of technical impracticability, EPA reviewed the human health and environmental risk assessments. With the completion of the soil remediation, recreational users of the Royal River are the only current human receptors. Potential future receptors include users of groundwater, Royal River, or Boiling Springs as a drinking water supplies. Of these receptors, unacceptable risk is associated with the drinking water use of groundwater or from Boiling Springs but not with the Royal River. (AR #6755)

A review of research data was performed to update the environmental risks. In addition to aquatic species in the Royal River, terrestrials species using Boiling Springs were identified as current and future receptors. The literature indicated contaminant concentrations measured in Boiling Springs could have a negative impact on some species, but that the contaminants at the concentrations detected in the Royal River did not pose a risk to aquatic species. (AR #6253)

5.0 Restoration Potential of the Site

This section provides an evaluation of the restoration potential of the Site. It includes a discussion of remaining sources, potential remedial technologies that have been evaluated for restoration of the aquifer, containment of the contamination plume, and a time frame analysis.

5.10 Assessment of Remaining Sources

The McKin Company ceased operation in 1977. Therefore, the activities which served as the source of the contamination are no longer continuing and there is no new release of contamination. What remains however, includes residual VOCS - contamination adsorbed to soil particles beneath the water table which were not excavated as part of the 1986 source control action, and potentially DNAPLs present in both the overburden and bedrock. These two act as ongoing, continuous sources as contaminants slowly dissolve into the groundwater.

Soil explorations conducted on the McKin property in 1985 detected TCE concentrations of up to 1,500 mg/kg (or parts per million, ppm). Similar concentrations were detected in sampling by Maine DEP in 1978. The maximum TCE concentration which the soil could be expected to hold without the presence of residual or free-phase DNAPL was calculated using the total porosity, TCE soil distribution coefficient, soil specific gravity, and a TCE solubility value of 1,100,000 μg/L (or parts per billion, ppb). The maximum value was about 600 mg/kg. Given the heterogeneity of the overburden soils, and therefore to accommodate the ranges in porosity, soil coefficient, and specific gravity, a factor of three was applied. This suggested that TCE concentrations in soil greater than 600 to 2,000 mg/kg would indicate the presence of residual DNAPL. Thus the measured concentrations reported in 1978 and 1985 indicate that DNAPL TCE may have been and could still be in the soils beneath the McKin property.

In groundwater, the maximum concentration of TCE measured beneath the McKin property was 130,000 μg/L. This 1982 measurement was from monitoring well MDEP Well 8. This well was located in the vicinity of the horizontal liquid waste storage tanks along the northeast border of the facility.

Off the McKin property, the maximum concentration measured in the bedrock was 29,000 μg/L at monitoring well B-1A which is located about 500 feet from the McKin property along Depot Road. The maximum concentration in the off-site overburden aquifer was 16,000 μg/L, measured at monitoring well B-1B (the overburden couplet of B-1A). Both of these measurements were collected in March 1984. (AR #6601)

These concentrations in groundwater suggest the presence of DNAPL. A commonly stated characterization of solubility is that concentrations in excess of one percent of a compound's solubility is indicative of the presence of that compound in free phase (i.e., the solvent is mobile and continues to migrate through the groundwater under the influence of gravity). The solubility of TCE in water as noted above is about 1,100,000 μg/L and therefore one percent would be 11,000 μg/L. The measured concentrations at Well 8 and B-1A and B-1B therefore exceeded the one percent value of TCE solubility and suggest the presence of DNAPL in both the overburden and bedrock aquifer, both on and off the McKin property. In addition to these wells, concentrations at wells B-3A (10,000 μg/L), EW-501 (7,700 μg/L), EW-503 (7,000 μg/L), and MW-206A (7,800 μg/L) and residential wells (8,200 and 7,880 μg/L) also approach the one percent solubility value and therefore provide an indication of the potential extent of the DNAPL entry zone (see figures 2 and 7 for monitoring well and residential well locations).(See AR #8456 for compilation of historical data)

See Table 3 from GEI AR#6758 for a list of maximum concentrations observed in the groundwater.

5.20 Potential Restoration Remedial Technologies

Aquifer restoration for the McKin Site is defined as the attainment of drinking water quality throughout both the overburden and bedrock aquifers in a time-effective manner. The May 1996 GEI Evaluation of Technical Impracticability (AR#6758) identified and screened in-situ and ex-situ technologies and natural attenuation, and then evaluated those retained after the screening against the criteria of effectiveness, implementability, and costs relative to restoring the aquifer.

Brief definitions of effectiveness, implementability, and relative cost, as they apply to the evaluation process, follow.

> Effectiveness - This criterion focuses on the potential effectiveness of process options in handling the estimated volume of media and meeting the remediation goals; the potential impacts to human health and the environment during construction and implementation; and how proven and reliable the process is with respect to the contaminants and conditions at the site.
>
> Implementability - The implementability evaluation encompasses both the technical and institutional feasibility of implementing a process. Technical implementability includes technology types and process options; institutional aspects of implementability include the ability to obtain permits, availability of treatment, storage, and disposal services, and availability of necessary equipment and resources.
>
> Cost - Cost plays a limited role in this screening. The cost analysis is based on engineering judgment, and each process is evaluated as to whether costs are high, low, or medium relative to the other options in the same technology type. If there is only one process option, costs are compared to other candidate technologies.

Two technologies, in-well sparging and bedrock extraction wells, were retained following the screening, but GEI concluded that both would be ineffective, difficult to implement and have high costs. These conclusions were based on the assumptions that there was residual DNAPL in the bedrock and overburden, locating the contamination in the bedrock would be virtually impossible, and prior computer modeling by the PRPs which indicated that regardless of how a treatment well system might be configured, it would take more than 200 years to reach the performance standards set in the 1985 ROD. GEI concluded that the only remedial alternative which would be protective of human health would be institutional controls over the impacted area.

EPA, while disagreeing with many of the assertions made in this screening evaluation of potential remedial technologies, agreed that restoration of the bedrock aquifer is not practical for the following reasons:

- The presence of contaminants in residential wells demonstrated there was a pathway from the McKin property to the bedrock aquifer;

- Vertical gradient data indicate that the potential DNAPL entry zone into the bedrock could extend for several hundred feet north from the McKin property, making the identification of the actual pathway(s) difficult to locate;

- The presence of TCE in shallow bedrock wells several thousand feet from the McKin property suggest the extent of the bedrock contamination;

- While the trend analysis of the monitoring wells shows TCE concentrations decreasing in a majority of the wells at comparable rates to the half-life seen elsewhere for TCE, other wells, such as shallow bedrock well MW-206A, have not. This suggests the presence of a nearby residual source;

- Residential bedrock wells were sampled in 1977 and some again in 1982. There is no current bedrock data. To accurately characterize the current extent of bedrock contamination would require an extensive and costly investigation.

- The December 1998 discovery of TCE in well GWD-1 in the overburden east of Collyer Brook in the vicinity of the Gray Depot area without an identified overburden plume connecting it to the McKin Site suggests bedrock transport; and

- The presence of contaminants in GWD-1, more than twenty years after use of the residential wells was stopped, indicates that contaminants remain in the bedrock and have not been flushed out by natural groundwater flow.

In addition to these realities relative to restoration of the bedrock, EPA also agreed that restoration of the overburden aquifer is not practical for the following reasons:

- The overburden plume extends across several hundred acres, yet there are two significant areas where the plume dimensions are poorly known. These are between Mayall Road and the 800-series monitoring wells, and virtually the entire northen plume north of the Mayall and Depot Road intersection. This would require substantial additional investigation efforts in order to make extraction of contaminants from these two areas effective.

- The saturated thickness of the overburden varies from a few feet near the facility and the bedrock knoll to over one hundred feet in the southerly trending bedrock trough. Any well placed within a limited thickness area would have limited effectiveness as demonstrated by EW-501 and EW-503 of the current system;

- Drilling logs indicate a discontinuous glacial till unit above the bedrock. Composed of nonsorted and nonstratified material, DNAPL adsorbed onto the lower permeability till will act as a source for the more permeable units;

- The known overburden plumes are situated beneath more than one hundred private properties. Obtaining access for investigations, and then construction and maintenance of a multi-well system through so many properties would be a difficult task, particularly that the depth to contamination/water table is such that it poses no risk via vapor migration to the property owners; and

- As noted previously, it is likely that DNAPL in residual form is present in the bedrock. Given the uneven bedrock surface, there are likely to be multiple areas where seepage occurs from the bedrock into the overburden.

Therefore, EPA concluded that institutional controls with long-term monitoring was the only remedial alternative which would be protective of human health.

Alternative GW-1: Institutional Controls and Long-Term Monitoring

In this alternative, EPA recognizes that first, the groundwater in the East Gray area will not be of drinking water quality for an extended period of time. Second, EPA also recognizes that this area faces continuing development pressure. Therefore, established, formal controls are needed to prevent use of the groundwater until the TCE concentrations attenuate to drinking water quality. This can best be accomplished through the overlapping controls developed in the mediation process where the Town of Gray would pass a zoning ordinance to prevent use of the groundwater in the impacted area; the PRPs would fund the Gray Water District to ensure a sufficient water supply for future growth in the East Gray area; and the PRPs would reach agreement with owners of sub-dividable properties to fund installation of water lines in exchange for deed restrictions preventing the installation of wells.

Long-term monitoring of the groundwater would allow EPA and Maine DEP to track the TCE concentrations within the plume and along the plume boundary. This data will allow the agencies to evaluate whether the concentrations are continuing to decrease at the rates projected and to ensure that the plume is not expanded.

See 1996 GEI (AR#6758) for further description of the technologies identified and screened for aquifer restoration.

5.30 Potential Containment Remedial Technologies

Containment at the McKin Site is defined as the capture of a sufficient amount of the TCE eastern plume so that the Royal River attains the State of Maine water quality standard.

5.31 Pre-mediation evaluation

The 1996 GEI (AR #6758) identified and screened in-situ and ex-situ technologies, natural attenuation, and institutional controls, and then evaluated those retained after the screening against the criteria of effectiveness, implementability, and costs relative to containing the plume.

From this identification, GEI retained the following to compare against the criteria: a no action alternative, permeable wall, in-well sparging, passive treatment walls, extraction wells, interceptor trench, slurry wall, natural attenuation and institutional controls. From this group, GEI performed a detailed analysis on extraction wells and in-well sparging.

GEI concluded that both technologies would be potentially effective only during part of the year, moderate to implement and have low to moderate costs. These conclusions were based on the assumptions that there was a significant amount of contaminated groundwater migrating through fractured bedrock which was discharging directly to the Royal River, implementation would result in significant damage to the uplands and flood plain adjacent to the river, would require at least one hundred years of operation and maintenance and complete system reconstruction every twenty-five years. Therefore, GEI concluded that containment was not an attainable goal and that institutional controls remained as the only effective means for being protective of human health.

The agencies disagreed with these assumptions and the conclusions. Following a six-month period where the parties were unable to resolve the issue of containment, EPA suggested the parties enter the mediation process. Through the mediation, EPA agreed to perform the remediation while the PRPs would remain responsible for long-term monitoring. EPA undertook a focused feasibility study (FFS) to evaluate the effectiveness of a containment remedy and concurrently, to refine the cost estimate for the remedy.

5.32 EPA Containment Evaluation

USGS, working through an inter-agency grant, established the width and concentration configuration of the plume entering the Royal River through the use of passive diffusion samplers (AR #6254). EPA's contractor, Tetra Tech NUS, conducted a focused investigation to determine the vertical distribution of the plume and the hydrological parameters in the area immediately upgradient of the river.(AR #8457) As a result of these investigations, EPA concluded that sufficient TCE-contaminated groundwater could be captured such that the Royal River would attain the State criteria.

Once the dimensions of the plume in the discharge zone were identified, Tetra Tech NUS identified remedial alternatives which might be feasible in attaining the goal. Remedial alternatives were developed by assembling combinations of technologies and the media to which they would be applied into an appropriate range of alternatives that address site contamination. In this case, the environmental medium of interest is surface water (Royal River and Boiling Springs) and the contaminant of concern is TCE. Although the objective of the focused feasibility study focused on surface water, the primary component of the remedial alternative is intercepting TCE-contaminated groundwater prior to its discharge into the Royal River.

In an effort to streamline the FS and to assemble a concise array of plausible alternatives, effectiveness, implementability, and cost were considered heavily in developing the remedial alternatives. As a result, only a limited number of alternatives were developed and all were considered to be technically, administratively, and economically feasible. Therefore, the formal screening of the alternative screening against effectiveness, implementability, and cost was not performed and all alternatives were retained for detailed analysis against the NCP's nine evaluation criteria.

The containment alternatives retained for evaluation using the NCP criteria included extraction wells along the flood plain with covering of Boiling Springs, extraction wells installed in uplands with covering of Boiling Springs, monitored natural attenuation with covering of Boiling Springs, and a no action alternative. In addition, Tetra Tech NUS evaluated both groundwater reinjection and surface water discharge for the first two alternatives.

Alternative SW-1: Long-Term Monitoring and Insurance Contingency

In this alternative, Boiling Springs would be covered to prevent contact with the contaminated spring water. The cover would be designed to allow the spring water to continue to flow into the Royal River. It would not be built to stop the flow of the spring water as that would only cause springs to reappear somewhere else in the flood plain, creating a new risk. Water quality at several locations in the Royal River would be monitored, and should the State SWQC not be met within the specified time, then Maine DEP would be able to trigger an active remedy guaranteed by an insurance policy.

Alternative SW-2: Flood Plain Groundwater Interception and Cover Boiling Springs

In this alternative, Boiling Springs would be covered as described above and a groundwater interception system would be constructed to capture a sufficient amount of this contaminated groundwater so that the State SWQC would be attained in the Royal River. The wells would be located in the Royal River flood plain area where the greatest volume of TCE-contaminated groundwater was moving through the soil. The treatment plant would be located in an upland area to prevent damage from seasonal flooding. The SQWC would be attained within a few months of operation.

Two discharge options for the treated groundwater were evaluated: reinjection back into the ground or a direct discharge into the Royal River.

It is anticipated that it would take approximately one year to design and construct the system. For costing purposes, it was planned that the system would be operated for fourteen years.

Alternative SW-3: Upland Groundwater Interception and Cover Boiling Springs

This alternative is similar to that in SW-2, except that the location of the interception system and treatment plant would be in the uplands, west of the pipeline right-of-way rather than in the flood plain. Again, two discharge options were evaluated.

EPA developed these alternatives based on information contained in the 1999 Feasibility Report prepared by Tetra Tech NUS, the trend analyses developed by the technical representatives of the mediation, and the 1996 TI Evaluation Report prepared by GEI, Inc. for the PRPs.

5.33 Evaluation using the NCP nine criteria

In conformance with the NCP, seven of the following nine criteria were used to evaluate each of the retained alternatives during the detailed analysis. The last two criteria, state and community acceptance, will be addressed following receipt of state and public comments on the TI.

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume Through Treatment
- Short-Term Effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance

Under the NCP, the selection of the remedy is based on the nine evaluation criteria, which are categorized into three groups:

- Threshold Criteria - The overall protection of human health and the environment, and compliance with ARARs are threshold criteria that each alternative must meet in order to be eligible for selection.

- Primary Balancing Criteria - The five primary balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost.

- Modifying Criteria - The state and community acceptance are modifying criteria that will be considered in remedy selection.

For further description of each of these evaluation criteria, see AR #8457, Section 4.1.

EPA used these criteria to evaluate the remedial alternatives. The table below summarizes how the proposed alternatives, GW-1 and SW-1, compare with the other alternatives in meeting the criteria.

The protection of human health and the environment is the most important criterion. The combination of Alternative GW-1 with any of the three surface water alternatives would *protect human health and the environment* as the institutional controls would prevent exposure to contaminated groundwater and the covering of Boiling Springs would prevent exposure to contaminated surface water.

Alternative GW-1 includes a TI waiver of drinking water standards and would *comply with all other identified Federal and State regulations*. All surface water alternatives would *comply with Federal and State regulations*. Installation of the interception of the groundwater in the flood plain (Alternative SW-2) would require additional efforts to minimize impact to the flood plain and associated wetlands.

The *long-term protection criterion* would be met by the combination of Alternative GW-1 with any of the surface water alternatives. The institutional controls will remain in effect and the monitoring will continue as long as the TCE concentrations remain above drinking water quality. Interception of the groundwater would prevent contaminant discharge into the Royal River and would continue until the amount entering the system was less than the State Surface Water Quality Criteria. The monitoring alternative, SW-1, includes a contingency that should the river not attain the criteria within the specified time, the State can require implementation of an active remedy.

Alternatives SW-2 and SW-3 would employ active remedies and therefore would *reduce the toxicity, mobility, and the volume of TCE through treatment* relative to the Royal River whereas the proposed alternatives GW-1 and SW-1 do not. As SW-2 and SW-3 would be located over 4,000 feet from the McKin facility, these alternatives would not effect the substantial portion of the groundwater plume and therefore would not meet this criterion relative to groundwater. The covering of Boiling Springs, a component of all three surface water alternatives, also does not meet this criterion, as it is designed specifically to <u>not</u> reduce the mobility of the TCE but rather to prevent contact with the TCE-contaminated water before it enters the Royal River.

Proposed alternatives GW-1 and SW-1 meet the *short-term effectiveness* criterion. The implementation of institutional controls reduces site risks quickly. Short-term risks to workers, the community, and the environment are minimal as the only construction activity with these alternatives is the installation of the boundary set of monitoring wells. Alternatives SW-2 and SW-3 would require standard engineering precautions to minimize short-term risks during the installation of the groundwater interception systems. Operation of either of these systems could require the disposal of carbon used to remove TCE from the pumped groundwater. In addition, the operation of the SW-2 system would require a certain amount of vehicular and pedestrian traffic in the flood plain and associated wetlands which would be expected to have some negative impact on these areas.

All of the alternatives can be built or *implemented*. The materials and equipment needed for installing monitoring wells, covering Boiling Springs, the groundwater interception systems are all readily available.

In evaluating the alternatives for *costs*, EPA has assessed the combination of GW-1 with the three surface water alternatives. As EPA has not identified any current public health or environmental risk associated with the TCE in the Royal River, all three surface water alternatives are protective of human health and the environment. Alternatives SW-2 and SW-3 by their active treatment would meet the State SWQC within months of installation whereas the time to reach the criteria by alternative SW-1 is considered likely to occur within five years, but may extend to thirteen years. Alternative SW-1 however costs appreciably less, $600,000 compared to $3.4 to $3.6 million for SW-2 and $3.7 to $3.9 million for SW-3.

Restoration and Containment Criteria Compared to the Nine Evaluation Criteria			
The Nine Criteria	**GW-1 and SW-1: institutional controls, long-term monitoring, cover Boiling Springs, river contingency**	**GW-1 and SW-2: institutional controls, long-term monitoring, cover Boiling Springs, flood plain groundwater interception**	**GW-1 and SW-3: institutional controls, long-term monitoring, cover Boiling Springs, upland groundwater interception**
1. Protects human health and the environment	yes	yes	yes
2. Meets federal and state requirements	yes, with TI waiver	yes, with TI waiver	yes, with TI waiver
3. Provides long-term protection	yes	yes	yes
4. Reduces toxicity, mobility, and volume through treatment	no	yes for surface water, no for groundwater	yes for surface water, no for groundwater
5. Provides short-term protection	yes	yes	yes
6. Implementable (can it be built?)	yes	yes	yes
7. Cost	$1,100,000	$3,900,000 - $4,100,000	$4,200,000 - $4,400,000
8. State acceptance	to be determined		
9. Public acceptance	to be determined after public comment period		

5.40 Remedial Time Frame Analysis

Groundwater

The May 1996 GEI report estimated that restoration of the groundwater aquifers and the Royal River would be greater than 200 years regardless of implementation of any active remedial technology (See AR#6758, Table 13). This included expansion of the GETS to east of Mayall Road. This estimate was based on the conceptual model, review of the groundwater quality data, and on prior computer modeling. The conceptual model developed by GEI assumed residual sources in both the overburden and bedrock and a significant amount of bedrock transport directly to the river. GEI stated that concentrations in monitoring wells outside the area of extraction well influence "have consistently ranged between 200 and 1,000 ppb since 1988" and that concentrations in wells within the area of influence "have remained relatively constant since GETS start up" (page 26). GEI concluded then that attaining the surface water criteria would take approximately the same time frame as attaining the clean-up standard for the groundwater.

The 1993 modeling had been done to evaluate the effectiveness of expanding the four-well groundwater extraction system east of Mayall Road. Various possible system expansions were evaluated, including systems with wells parallel and/or perpendicular to the plume, and with single or multiple rows of extraction wells. The output from this modeling effort indicated that restoration time would be greater than 200 years regardless of the system configuration.

EPA interpreted the data differently from GEI. Rather than fluctuating, EPA believed the groundwater data indicated a a steady decline from historical high concentrations at nearly all wells. The date of the historical high concentration varied from well to well; for some it occurred prior to soil remediation, for others it occurred subsequent to the GETS start-up. Nonetheless, EPA's overall view was that TCE concentrations in the groundwater were decreasing, and even, at some locations, meeting the ROD-set clean-up standard.

In October 1997, during the initial period of the McKin mediation, SME suggested that groundwater may reach clean-up standards in forty to fifty years. In as much that was significantly different from what had formally been projected, <u>and</u> would significantly impact any remediation cost estimate, in November, members of the mediation technical subcommittee worked to refine the time frame estimates for groundwater restoration.

The monitoring well data were graphed. From these graphs consensus was reached as to when the downward trend began at each well. Using the agreed upon set of data points, a regression analysis was performed. Using the semi-log graph, a linear decay rate was noted. For the majority of the wells evaluated, the TCE half-life was about three years, and the average time to reaching the ROD clean-up standard, (assuming a continuous decay without reaching an asymptotic limit) was just over ten years and the maximum was forty-three years. (AR #6596) To accommodate the likelihood of an asymptotic limit, and that some wells such as B-4 were excluded from this analysis because of increasing concentrations (small in comparison to the concentrations measured in the other wells) or because their half-life was significantly greater, MW-401A had a half-life of 55 years for example, the technical subcommittee agreed to report back to the mediation committee an expectation of forty to fifty years to groundwater restoration.

Surface Water

In October 1997, SME estimated that surface water criteria would be achieved at harmonic mean flow in eight to ten years (2005 to 2007) and in fifteen to twenty years (2012 to 2017) at low-flow conditions. These estimates were based on increased accuracy of mass flux calculations using a river gauge installed near Boiling Springs rather than extrapolating from a downstream USGS gaging station, a decrease in TCE loading from 2-3 kg/day in 1991-1992 to about 1 kg/day in 1997, and the linear decay observed in groundwater. As the maximum river concentration was about ten times greater than the criteria, it was thought that a ten-fold decrease in groundwater was needed. (AR #6403)

Consequently, the technical committee performed a regression analysis on the surface water data. The Boiling Springs analysis matched well with the monitoring wells, with a half-life of 2.76 years and 15.8 years to cleanup. The regression of the SW-1 data coincided with the SME estimation. (Table 5) As SW-1 is located 2,800 feet downstream from Boiling Springs, as the R^2 value, a statistical indication of the range of the data, was less than optimal, and as well as concern over the possible tailing off of the mass flux values, the technical committee agreed to report back to the mediation committee an expectation of fifteen years to attaining river compliance. This time period was then used in developing cost estimates for containment alternatives.

Since these initial evaluations, SME and EPA's contractor continued to update the regression analyses and projections for attaining the surface water criteria. (AR #6398, 6583, 6598, 6600, 6606, and Figure 17) The time estimates and statistical correlations have shifted slightly, both forward and back, but remain essentially the same. This then suggests that the river and groundwater data are continuing to be consistent with each other and neither has reached an asymptotic limit.

Compliance Assessment

As noted above, groundwater is expected to reach the current drinking water standards within fifty years and the State Surface Water Quality Criteria within the next six to eight years. As part of the mediation process, a long-term monitoring plan was developed which specified sampling locations, sampling frequency and analytes for groundwater and the Royal River. Since the groundwater restoration time frame was sufficiently far into the future, the technical representatives in the mediation did not include in the long-term monitoring plan how compliance with the drinking water standards would be determined. Instead, it was agreed that a compliance methodology would be developed as the water quality data approached the applicable standards.

A methodology for attainment of the surface water criteria was developed for use in the insurance policy. It includes a two-tier evaluation based on data from historical sampling location SW-1 in the year 2009 and at a new location to be sampled starting with the implementation of the long-term monitoring plan, SW-201, in the year 2013.

6.0 Cost Estimates for Proposed Remedial Options

EPA guidance states that net present worth costs estimates are to made for 30 years using a 7% discount rate. GEI chose to develop net present worth cost estimates based on 100 years of O&M and used a 2% discount rate.

GEI did not develop costs for aquifer restoration as they did not believe any technologies could potentially restore the bedrock and overburden aquifers within a reasonable time frame. Tetra Tech NUS did not develop costs for aquifer restoration as that was outside the scope of work for the focused feasibility study.

Cost estimates for containment alternatives were developed by GEI for its 1996 report (AR #6758) and by Tetra Tech NUS for its August 1999 FS (AR #8457). As noted above, the inability to reach agreement on the Site conceptual model as presented in the GEI document led to the mediation effort. That document produced a large number of comments by the reviewing agencies including comments on the cost estimates. (AR #6591 and 6592) The agencies viewed the GEI estimates to be excessively high. As the inability to resolve technical issues brought up by this report precipitated the mediation effort, this document was never finalized and never approved by the agencies. Likewise, the Tetra Tech cost estimates did not undergo scrutiny by the PRPs. Nonetheless, these costs are presented here to provide a more complete picture of the development of the current assessment.

GEI estimated the costs for the two containment alternatives they retained for detailed analysis. The costs for both alternatives included predesign fieldwork, design, installation, and then operating each for 100 years The estimate for the groundwater extraction system was $113 million and for in-well sparging it was $75 million. The chief difference between the two was attributed to the elimination of costs associated with ex-situ groundwater treatment. See AR#6758, Sec.6.7 for further description.

Tetra Tech NUS estimated the costs for the retained remedial alternatives in the FS: extraction wells in the flood plain, extraction wells located upland of the flood plain, surface water monitoring, and a no action alternative. In addition, Tetra Tech NUS developed a cost estimate for the covering of Boiling Springs and costs for both reinjection and surface water discharge for the treated groundwater. The costs for both active alternatives included predesign fieldwork, design, installation, and then operating each for eleven years[1].

The net present worth estimate for the flood plain groundwater extraction system with reinjection of the treated groundwater was $3,850,000 over a fifteen year period. The net present worth estimate for the flood plain groundwater extraction system with surface water discharge of the treated groundwater was $3,715,000 over a fifteen year period.

The net present worth estimate for the upland groundwater extraction system with reinjection of the treated groundwater was $4,180,000 over a fifteen year period. The net present worth estimate for the upland groundwater extraction system with surface water discharge of the treated groundwater was $3,920,000 over a fifteen year period.

The net present worth estimate for the surface water monitoring with covering of Boiling Springs was $1,380,000. The net present worth estimate for the no action alternative was $72,000. (See Sections 4.1.1 through 4.1.4 and Appendix K in AR #8457 for further information on the cost estimates).

7.0 Protectiveness of Proposed Remedial Options

Remedial alternatives at a Superfund site must meet the two threshold criteria specified in the NCP to be eligible for selection: 1) the remedy must be protective of human health and the environment; and 2) the remedy must meet (or provide the basis for waiving) the ARARs identified for the action.

The proposed remedial option of institutional controls and long-term monitoring for groundwater, covering of Boiling Springs, and long-term monitoring with a contingency for surface water achieves the first threshold criteria and complies with all ARARs with the exception of chemical-specific ARARs for groundwater. This TI report provides the basis for waiving chemical-specific ARARs for groundwater. Long-term monitoring will ensure that groundwater continues to meet all chemical-specific ARARs at the institutional control zone boundary and that the concentrations within the plume will continue to decline toward ARARs.

In its evaluation, GEI concluded there were no technologies which could restore the aquifer within a reasonable time frame and therefore, in order to meet the first threshold criteria, institutional controls were a necessary component of any remedy. Unable to restore the aquifer through active efforts and to actively eliminate the toxicity, effective institutional controls can

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[1]When EPA began the FS, the technical sub-committee of the mediation process agreed to use a time frame of fifteen years to evaluate costs. In this way, all cost estimates would be based on the same time. As the mediation progressed, and as additional data regressions were developed, the projections for actual operation decreased to eleven years. For the FS and this TI, the costs for 15 years are retained.

eliminate the exposure pathway for TCE and other VOCs and thereby provide protectiveness of human health from the contaminated groundwater.

EPA believes that protectiveness relative to groundwater can be achieved by the overlapping institutional controls developed through the mediation process. These overlapping controls include a town ordinance, ensuring a public water supply, and deed restrictions preventing the installation of water wells on sub-dividable parcels of private property. These controls prevent ingestion of contaminated groundwater and inhalation (produced from hot water such as in a shower) which were the exposure pathways found to pose an unacceptable human health risk.

Tetra Tech NUS, in its focused feasibility study of the Royal River Discharge Zone, identified two containment remedies which would be protective of human health and the environment relative to surface water contamination. Through the covering of Boiling Springs, a component of both containment remedies, the proposed remedial option is protective of human health and the environment relative to these springs. Through the monitoring of the Royal River, with the contingency for implementing an active containment remedy should the TCE concentrations not continue to decline at the current rate, the proposed remedial option is protective of human health relative to the Royal River (TCE concentrations measured in the river have not constituted an environmental risk and are not anticipated to do so in the future).

8.0 Summary and Conclusions

This report provides a summary of data presented in documents which were principally produced during the period May 1996 to August 1999. These documents were prepared by consultants for the McKin Superfund Site PRPs and by contractors for EPA. Additional data was provided by Maine DEP and by the Town of Gray. Some of these documents were produced explicitly in conjunction with the technical impracticability evaluation while others were prepared for other purposes (such as quarterly monitoring). Combined, they were used to provide an assessment of the technical practicability of achieving groundwater and surface water standards for TCE and other volatile organic compounds within a reasonable time frame.

Groundwater contamination in bedrock water supply wells near the McKin facility was first detected over twenty-five years ago. Investigations of the overburden and shallow bedrock revealed that the contamination had spread outward from the McKin facility through the groundwater toward the Royal River and Collyer Brook. By 1989 measurable amounts of TCE were detected in the Royal River.

Efforts to estimate a time frame for restoration of the aquifers began in the early 1990s with a computer groundwater model suggesting over 200 years before the remediation goal for the Site would be achieved. This led to discussions between the PRPs, EPA and Maine DEP over the technical impracticability of groundwater restoration. Unable to reach agreement, the parties entered mediation in June 1997. Through further evaluation of the data, the parties agreed that the overburden aquifer should meet MCLs in approximately fifty years and the Royal River should meet the State Ambient Water Quality Criteria in six to eight years. The parties reached concurrence in November 1999. Included in this concurrence was the agreement that it was technically impractical to restore the several hundred acres of contaminated aquifer.

This agreement was based on the direct and indirect evidence presented in Section 5.20 of this report, with the main points being: (*i*) contamination in the form of dissolved VOCs has entered the bedrock; (*ii*) it is a reasonable possibility that residual and perhaps free-phase DNAPL exist in the bedrock; (*iii*) hydraulic gradients demonstrate that there is an interconnection between bedrock and overburden, with the bedrock acting as a source of contamination for the overburden; (*iv*) there is no current picture of the extent of bedrock contamination since no deep bedrock data has been collected in almost twenty years (deep bedrock remediation was ruled out in the 1985 ROD); and (*v*) time frames for restoration of the overburden and shallow bedrock based on performed jointly by the agencies and PRPS indicate up to fifty years for some wells.

Therefore, given that the aquifer served as the sole source of potable water prior to its contamination, that the area continues to experience growth, and there is uncertainty regarding the water quality of the bedrock, EPA determined that fifty years for restoration of the overburden was an unacceptable time frame for groundwater restoration. EPA concluded that it is technically impracticable to attain MCLs in the plume within a reasonable time frame.

The regression analysis did support the decrease of contamination in the groundwater and surface water. However, whereas the overburden groundwater is expected to remain above standards for up to fifty years, the regression analysis for the surface water projected that the Royal River will meet the State standard in about 2005. Therefore, the agencies concluded that monitoring with a contingency was an appropriate remedial alternative for surface water. The contingency, an insurance policy which allows the Maine DEP to require active remedial actions should the standard not be met within the agreed-upon time, was deemed necessary because the data fluctuation produced a range up to fourteen years before compliance is fully achieved.

MCKIN SUPERFUND SITE

GRAY, MAINE

TABLES

TABLE 1--1982 WATER SAMPLE LOCATIONS AND TEST RESULTS

(Sample locations are shown by numbered arrows on Figure 7)

No. (Fig 7)	Map Designation (Figure 7)	Land Owner	Tax Map	Lot No.	Maine Coordinates North	Maine Coordinates East	DEP Sample Number	TCE µg/l	TCEy µg/l	Notes/Other
1	Gerber--B101A	Blue Rock Indust.	33	30	383,930	465,030	----	--	—	Could not sample well
2	Gerber--B102	Lucymae Bowles	39	10	383,610	469,720	104558	J71	J120	Methyl ethyl ketone J13,000
3A	Gerber--B103 soil	Fred. Farrell	38	13	383,080	470,220	105111	K1	K1	
3B	Gerber--B103 rock	Fred. Farrell	38	13	383,080	470,220	105137	K1	K1	
4A	Gerber--B104 upper	Emerson Mitchell	39	8	386,020	467,020	105017	K1	K1	Electron capture detection
4A	Gerber--B104 upper	Emerson Mitchell	39	8	386,020	467,020	----	K0.1	0.5	ERCO test results
4B	Gerber--B104 deep	Emerson Mitchell	39	8	386,020	467,020	105019	K1	K1	Electron capture detection
5	DEP Well 8 (site)	Richard Dingwell	38	20	382,990	466,140	----	--	—	Could not sample
6	DEP Well 13 (site)	Richard Dingwell	38	20	382,660	466,370	105074	K1	K1	
6	DEP Well 13 (site)	Richard Dingwell	38	20	382,660	466,370	105073	16	0.7	ERCO test results
7	DEP Well 14 (site)	Michael Valente	38	35	382,690	466,070	105076	K1	K1	
8	DEP Well 15 (site)	Michael Valente	38	35	382,890	465,890	105075	K1	K1	
9	DEP Well 7 (site)	Michael Valente	38	35	383,310	466,130	104192	53	130,000	Methylene chloride J100
10	Test Well 17	Blue Rock Indust.	33	30	382,910	464,770	104577	K1	K1	
11	Drilled well 1	Ralph Wink	39	20	385,880	470,100	----	--	--	Could not sample
12	Drilled well 2	David Eldridge	39	14A	386,660	469,030	----	--	--	Could not sample
13	Drilled well 3	John Betz	39	13	385,740	467,920	105108	2	9	
14	Drilled well 4	Philip Humphrey	39	12A	384,970	468,070	105147	200	1100	ERCO test results
14	Drilled well 4	Philip Humphrey	39	12A	384,970	468,070	105148	210	980	ERCO test results
15	Drilled well 9	Richard Wear	38	19A	384,450	466,440	105181	K1	5	
16	Drilled well 6	Emerson Mitchell	39	8	385,350	466,280	104508	K1	5	
17	Drilled well 15	Nat. Green	38	18	383,860	466,520	105034	650	8200	Methylene chloride J72
18	Drilled well 21	Brian Hascall	38	19L	383,420	466,520	105110	K1	K1	Acetone contamination--questionable
19	Drilled well 7	Louis Marstaller	33	14-1	385,480	464,030	105143	K1	K1	Electron capture detection
20	Drilled well 24	Alice Spear	33	18	381,970	463,280	104514	K1	K1	Electron capture detection
21	Spring	Kilton Lamb, Jr.	39	2E	387,540	466,370	105014	K1	K1	Electron capture detection
22	Spring	Emerson Mitchell	39	8	386,290	466,520	104511	K1	12	
23	Spring	Emerson Mitchell	39	8	386,030	467,140	105144	K1	K1	Electron capture detection
24	Spring	Lucymae Bowles	39	10	384,410	467,640	104529	K1	K1	Electron capture detection
24	Spring	Lucymae Bowles	39	10	384,410	467,640	105020	25	K0.1	ERCO test results
25	Spring	Lucymae Bowles	39	10	384,200	469,000	105008	K1	K1	
26	Spring	Lucymae Bowles	39	10	383,810	467,580	104586	K1	K1	Electron capture detection
27	Spring	Lucymae Bowles	39	10	383,570	468,640	105022	K1	K1	
28	"McKin Spring"	Fred. Farrell	38	13	382,800	466,950	104560	K1	K1	Electron capture detection
29	Spring	Fred. Farrell	38	13	382,770	469,230	105009	K1	K1	Electron capture detection
30	"Boiling Spr. #1"	Fred. Farrell	38	13	383,480	469,970	104559	130	88	Trichloro fluoro methane present
30	"Boiling Spr. #1"	Fred. Farrell	38	13	383,480	469,970	104515	140	150	ERCO test results
31	Spring	Matthew Morrill Trus.	33	16	384,360	464,270	105163	K1	K1	Electron capture detection
32	Meadow Brook	Ken. Sawyer/CMP Co.	32	3	380,250	459,540	104512	K1	K1	Electron capture detection
33	Collyer Brook	Ralph Wink	39	20	386,050	470,500	105007	K1	K1	Electron capture detection
34	Royal River	Brickyard Sta, N.Yar	--	--	377,050	475,000	105023	3	1	

Explanatory Notes: 1) Water quality concentrations are expressed in µg/l (parts per billion). 2) All water quality analysis was done by the Maine Dept. of Environmental Protection by Mass Spectrometer Dectection, except as noted. 3) TCE = 1,1,1-trichloroethane; TCEy = trichloroethylene. 4) ERCO = Energy Resources Company, Inc., Cambridge, Massachusetts. 5) Arrow numbers 1, 5, 11, 12 are not shown on Figure 7 since they were not sampled. 6) K = less than; J = approximately

Table 2: Chemical-Specific ARARs

ROYAL RIVER DISCHARGE ZONE
DRAFT FEASIBILITY STUDY
McKIN SITE, GRAY, MAINE

MEDIA	REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
Groundwater, Surface Water	FEDERAL - SDWA- Maximum Contaminant Levels (MCLs) (40 CFR 141.11-141.16)	MCLs have been promulgated for a number of common organic and inorganic contaminants to regulate the concentration of contaminants in public drinking water supply systems. MCLs may be relevant and appropriate for the RRDZ because the Royal River is a potential future drinking water supply.	MCLs may be used in determining action levels for surface water and treatment levels for extracted groundwater that is disposed of through direct discharge or groundwater reinjection.
Groundwater, Surface Water	FEDERAL - SDWA -Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50-141.51)	MCLGs are health goals for public water systems. MCLGs are set at levels that will result in no known or anticipated adverse health effects with an adequate margin of safety. Non-zero MCLGs are to be used when MCLs have not been established	MCLs may be used in determining action levels for surface water and treatment levels for extracted groundwater that is disposed of through direct discharge or groundwater reinjection.
Groundwater, Surface Water	FEDERAL-EPA Risk Reference Doses (RfDs)	RfDs are dose levels developed based on noncarcinogenic effects and are used to develop Hazard Indices. A Hazard Index of less than or equal to 1 is considered acceptable.	EPA RfDs will be used to characterize risks due to exposure to contaminants in surface water.
Groundwater, Surface Water	FEDERAL - EPA Carcinogen Assessment Group Potency Factors	Potency Factors are developed by the EPA from Health Effects Assessments or evaluation by the Carcinogenic Assessment Group and are used to develop excess cancer risks. A range of 10^{4} to 10^{6} is considered acceptable.	EPA Carcinogenic Potency Factors will be used to compute the individual incremental cancer risk resulting from exposure to site contamination in surface water.
Groundwater, Surface Water	STATE - Maine Safe Drinking Water Act (22 MSRA §§ 2611, 2612, and Maine Department of Human Services Rule 10-144 A CMR c. 231-233)	Maine primary drinking water standards are equivalent to federal MCLs.	MCLs may be used in determining action levels for surface water and treatment levels for extracted groundwater that is disposed of through direct discharge or groundwater reinjection.
Surface Water	STATE -Maine Water Classification Program (38 MSRA §§ 464-470)	This program sets forth standards for the classification of Maine's waters. The Royal River is classified as a Class B river/stream. Discharges to these waters cannot lower water quality below the designated classification.	Maine standards for Class B water prohibit the discharge of TCE in excess of 2.7 ppb, based on human health for consumption of water and organisms.
Groundwater, Surface Water	STATE -Maine Hazardous Waste management Rules, 06-096 CMR c. 854	This rule establishes the standards applicable to the establishment, construction, and operation of waste facilities for hazardous waste in Maine.	Must meet performance standards at waste management boundary.

Table 2: Chemical-Specific ARARs

POTENTIAL CHEMICAL-SPECIFIC ARARs AND TBCs
ROYAL RIVER DISCHARGE ZONE
DRAFT FEASIBILITY STUDY
McKIN SITE, GRAY, MAINE
Page 2 of 2

MEDIA	REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
Groundwater, Surface Water	STATE - Rules Relating to Testing of Private Water Systems for Potentially Hazardous Contaminants (Maine Department of Human Services Rule 10-144A CMR c. 233, Appendix C)	Establishes the mechanism/procedures for testing of private residential water supplies. This program assists applicants in determining the possible existence of potentially hazardous contaminants in the water supply. Appendix C provides Maximum Exposure Guidelines (MEGs) and Action Levels for inorganic chemicals, pesticides, and organics.	MEGs may be considered in determining action levels for surface water and treatment levels for extracted groundwater that is disposed of through direct discharge or groundwater reinjection.
Groundwater, Surface Water	STATE - Maine Department of Human Services, Maximum Exposure Guidelines for Drinking Water (MEGs) (Memorandum, 10/23/92)	MEGs are non-promulgated risk-based guidelines developed as recommended maximum levels of contaminants in drinking water [carcinogenic risk of 1 E-05, and no lifetime adverse effects]. MEGs have been referenced in amendments to the Maine Hazardous Waste Management Rules, Solid Waste Management Act, and the Underground Storage Tank Regulations as performance standards for groundwater remediation.	MEGs may be considered in determining action levels for surface water and treatment levels for extracted groundwater that is disposed of through direct discharge or groundwater reinjection.

Technical Impracticability McKin Site

Table 3: Location-Specific ARARs

ROYAL RIVER DISCHARGE ZONE
DRAFT FEASIBILITY STUDY
McKIN SITE, GRAY, ME

MEDIA	REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
Floodplain	FEDERAL-Floodplain Executive Order (EO 11988) (Statement of Procedures on Floodplain Management and Wetlands Protection, 40 CFR Part 6, Appendix A)	Federal agencies are required to reduce the risk of flood loss, to minimize the impact of floods, and to restore and preserve the natural and beneficial value of floodplains.	esponse action will be implemented in a ianner that will have no adverse impacts on the loodplain.
Sediments, Wetlands	FEDERAL-CWA-Section 404(b)(i) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230)	Section 404 of the CWA regulates the discharge of dredged or fill material into U.S. waters. The purpose of Section 404 is to ensure that proposed discharges are evaluated with respect to the impact on the aquatic ecosystem. The guidelines maintain that no dredged or fill material discharge will be permitted if there is a practicable alternative with less impact to the aquatic system. Discharge also will not be permitted unless steps are taken to minimize adverse impacts, or if it will cause significant degradation of U.S. waters.	ny wetlands adversely affected by the remedial ction will be restored or replaced.
Wetlands	FEDERAL-Wetlands Executive Order (EO 11990) (Statement of Procedures on Floodplain Management and Wetlands Protection, 40 CFR Part 6, Appendix A)	Under this order, federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and preserve and enhance the natural and beneficial use of wetlands. This order is relevant and appropriate to Superfund remedial actions performed by private parties.	ny wetlands adversely affected by the remedial ction will be restored or replaced.
Floodplain	FEDERAL - RCRA Floodplain Restrictions for Hazardous Waste Facilities (40 CFR 264.18(b))	A hazardous waste facility located in a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	lternatives are not expected to locate a izardous waste facility construction within odplain areas on site.
Wetlands, River	FEDERAL - 16 USC 661 et. seq., Fish and Wildlife Coordination Act	Requires federal agencies to take into consideration the effect that water-related projects will have on fish and wildlife. Requires consultation with the U.S. Fish and Wildlife Service and the state to develop measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife.	levant federal and state agencies will be ntacted to help analyze the effects of remedial tions on wildlife in wetlands and river.
Surface Water, Air, Wetlands	STATE-Maine Site Location Regulations-No Adverse Environmental Effect Standard of the Site Location Law (38 MRSA §§ 481 et seq. and regulations at c. 375)	These regulations prohibit any development from affecting the existing uses, scenic character, or existing natural resources in or near a community. Of particular concern are adverse impacts on air quality, drainage ways and infiltration relationships, erosion and sedimentation controls, and surface water. The regulations also prohibit excessive noise from developments.	though a permit is not required, the response tion will comply with the substantive quirements of these regulations.

Table 3: Location-Specific ARARs

ROYAL RIVER DISCHARGE ZONE
DRAFT FEASIBILITY STUDY
McKIN SITE, GRAY, MAINE
PAGE 2 OF 2

MEDIA	REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
Surface Water, Wetlands	STATE-Maine Natural Resources Protection Act (38 MSRA §§ 480-A thru 480-D and regulations at c. 305, 310)	This act prescribes standards for specific activities that may take place in or adjacent to water bodies to prevent the degradation or destruction of these areas. These activates must not interfere with existing scenic, aesthetic, recreational, or navigational uses in these areas.	Although a permit is not required, the substantive aspects of these requirements will be met. Response action will be implemented in a manner that would not interfere with the existing scenic, aesthetic, recreational, or navigational uses of the area.
All	STATE-Maine Site Location Development Law and Regulations (38 MRSA Sections 481-490; CMR Chapter 375)	This act and these regulations govern development and include hazardous activities that consume, generate, or handle hazardous wastes and oil. Activities cannot adversely affect existing uses, scenic character, or natural resources in the municipality or neighbouring municipality. The regulations provide that there shall be no unreasonable adverse effects on specified items (including air quality, runoff/infiltration relationships and surface-water quality), no unreasonable alteration of climate or natural drainageways, and provision for erosion and sedimentation control and noise control.	Response actions will comply with these requirements, if deemed appropriate.
All	STATE-Maine Inland Fisheries and Wildlife Laws and Regulations (12 MRSA Chapter 713, Section 7751)	The state of Maine has authority to research, list, and protect any species deemed endangered or threatened, as listed in the state regulations. The Maine Department of Inland Fisheries and Wildlife also has developed the following administrative categories for species not considered endangered or threatened but considered important for research and further evaluation: Maine Watch List, Special Concern List, and Indeterminate Category. The department determines appropriate use(s) of various habitats on a case-by-case basis. The Maine lists may differ from the federal lists of endangered species.	While no endangered or threatened species have been identified on site, these lists will be reviewed to assess whether Maine-listed species may be present. During the remedial action, measures would be implemented to protect these species, if encountered.
Wetlands	STATE-Maine Wetlands Protection (CMR Chapter 310, Section 1)	These regulations outline requirements for certain activities adjacent to any freshwater wetland greater than 10 acres or with an associated stream, brook, or pond. The activities must not unreasonably interfere with certain natural features, such as natural flow or quality of any waters, nor harm significant aquatic habitat, freshwater fisheries, or other aquatic life.	Response actions would meet activity standards. Substantive requirements of these regulations must be met for actions taken within 100 feet of wetland or stream.
All	STATE-Endangered Species Act (16 USC 1531 et seq.; 40 CFR 6.302(h))	This statute requires that federal agencies avoid activities that jeopardize threatened or endangered species or adversely modify habitats essential to their survival. Mitigation measures should be considered if a listed species or habitat may be jeopardized.	Although no endangered or threatened species were identified on site, their presence has been noted in the area. Removal alternatives would ensure that listed species or habitats would not be adversely affected.

Table 4: Action-Specific ARARs

ROYAL RIVER DISCHARGE ZONE
DRAFT FEASIBILITY STUDY
McKIN SITE, GRAY, MAINE

MEDIA	REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
Groundwater	FEDERAL-SDWA-Maximum Contaminant Levels (MCLs) (40 CFR 141.11-141.16)	MCLs have been promulgated for a number of common organic and inorganic contaminants. These levels regulate contaminant in public drinking water supplies and are also considered relevant and appropriate for groundwater aquifers potentially used for drinking water.	MCL for TCE will be used as a baseline measure to evaluate the performance of the response action.
Groundwater	FEDERAL-SDWA-Maximum Contaminant Level Goals (MCLGs) (40 CFR 141.50-141.51)	MCLGs are health goals for public water systems. MCLGs are set at levels that will result in no known or anticipated adverse health effects with an adequate margin of safety. Non-zero MCLGs are to be used when MCLs have not been established.	MCLGs for TCE and TCA will be used as a baseline measure to evaluate the performance of the response action.
Groundwater	FEDERAL-RCRA-Groundwater Monitoring (40 CFR §§ 265.90-265.94)	These regulations establish groundwater monitoring requirements for surface impoundments, landfills, or land treatment facilities used to manage hazardous waste.	The response action will comply with these requirements.
Surface Water	FEDERAL-CWA-The National Pollutant Discharge Elimination System (40 CFR Part 122 and 125)	This EPA administered permit program imposes limitations on the discharge of pollutants from a point source into the waters of the United States.	All NPDES substantive requirements will be followed for potential discharges to the Royal River.
Surface Water	STATE-Maine Regulations Relating to Water Quality Criteria for Toxic Pollutants (c. 584)	These regulations establish surface water quality criteria. In particular, ambient levels of toxic pollutants cannot exceed federal water quality criteria.	Any potential discharge to surface water must comply with these regulations.
Hazardous Waste	FEDERAL-RCRA-Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262, Subpart A)	Requirements establish standards for storage, labeling, accumulation times, and disposal of hazardous waste.	Hazardous waste generated during response actions will be handled and disposed in accordance with these standards.
Hazardous Waste	STATE - Maine Hazardous Waste Management Rules, 06-096 CMR c.850-857	These rules govern management of hazardous waste.	Hazardous waste generated during response actions will be handled and disposed in accordance with these rules.
Solid Waste	STATE - Maine Solid Waste Management Rules, 06-096 CMR c.400.1	Establishes rules for handling non-hazardous waste.	Non-hazardous waste generated during response actions will be handled in accordance with these rules.

Table 4: Action-Specific ARARs

ROYAL RIVER DISCHARGE ZONE
DRAFT FEASIBILITY STUDY
McKIN SITE, GRAY, MAINE
PAGE 2 OF 2

MEDIA	REQUIREMENT	REQUIREMENT SYNOPSIS	CONSIDERATION IN THE FS
Air	FEDERAL-RCRA-Air Emission Standards for Process Vents (40 CFR Part 264, Subpart AA)	Contains air emission standards for process vents associated with various treatment processes including air stripping. Standards apply to facilities that manage hazardous wastes with organic concentrations of at least 10 ppmw.	Air stripping operations will be conducted to meet these standards. Applicable, if organic concentrations in waste are equal to or greater than 10 ppmw.
Air	FEDERAL-RCRA-Air Emission Standards for Equipment Leaks (40 CFR Part 264, Subpart BB)	Contains air emission standards for equipment leaks at hazardous waste treatment, storage, and disposal facilities. Includes design specifications and monitoring requirements. Applies to equipment contacting wastes with at least 10% organics by weight.	Hazardous waste treatment facility will be constructed, maintained and monitored as required. Applicable, if organic concentrations in waste are equal to or greater than 10% by weight.
Air	FEDERAL-RCRA-Air Emission Standards for Tanks, Surface Impoundments, and Containers (40 CFR Part 264, Subpart CC)	Contains air emission standards for treatment, storage, and disposal facilities using tanks, surface impoundments, and containers to manage hazardous wastes containing at least 100 ppmw VOCs.	Emissions from excavated soils and sediments will be monitored and controlled prior to off-site disposal. Applicable, if at least 100 ppmw VOCs are contained/impounded.
Air	FEDERAL-EPA Policy on Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites (OSWER Directive 9355.0-28)	Provides guidance on the controlling air emissions from air strippers used for groundwater treatment at Superfund sites.	Emissions from air strippers will be monitored and controlled in accordance with this policy.
Air	STATE-Maine Air Pollution Control Laws-Maine Emissions License Regulations (38 MSRA §§ 585, 590 and regulations at c. 115)	Requires new sources of air emissions to demonstrate that its emissions do not violate ambient air quality standards. New sources must meet preconstruction monitoring and post-construction monitoring requirements.	Although a license is not required under CERCLA, the substantive requirements of this regulation will be met for off-gas treatment.

Table 5: Historical Loading Rates at SW-1

SEPTEMBER 1989 to May 2000

(Rev. 12/99)

Date	Royal River Flow Rate at Yarmouth	Estimated Royal River Flow Rate at SW-1	TCE Concentration at SW-1	Qualifier	Loading Rate Based on V-A Measurement or Latest S-D Data 0-250 cfs	Log 10 Loading Rate	Yearly Loading Rate Standard Deviation	Average Yearly Loading Rate
	(cfs)	(cfs)	(µg/l)		(Kg/Day)		(Kg/Day)	(Kg/Day)
Average		117	11		1.33	0.08	0.4	1.4
Standard Deviation		130	10		0.70	0.19	0.3	0.6
Max		615	37.0		4.1	0.6	1.1	2.7
Min		16	0.8		0.6	-0.2	0.1	0.8
9/20/89 0:00	51	27	13.0		0.86	-0.07	0.3	1.1
10/31/89 0:00	70	37	15.0		1.34	0.13		
5/15/90 0:00	720	336	#N\A	<5				1.7
8/13/90 0:00	289	141	5.0	5T	1.72	0.24		
10/25/90 0:00	1360	615	#N\A	<5				
1/25/91 0:00	102	52	16.0		2.05	0.31	0.3	1.9
4/16/91 0:00	380	183	5.0	5T	2.24	0.35		
7/17/91 0:00	37	20	37.0		1.80	0.26		
10/25/91 0:00	158	79	8.0		1.55	0.19		
1/30/92 0:00	109	56	30.0		4.09	0.61	1.1	2.7
4/21/92 0:00	621	292	4.0	4J	2.86	0.46		
7/15/92 0:00	82	43	20.0		2.08	0.32		
10/9/92 0:00	36	19	35.0		1.66	0.22		
2/4/93 0:00	70	37	26.0		2.33	0.37	0.8	2.2
4/7/93 0:00	963	443	3.0	3J	3.25	0.51		
8/18/93 0:00	30	16	37.0		1.48	0.17		
10/27/93 0:00	49	26	25.0		1.59	0.20		
1/20/94 0:00	94	48	10.0		1.18	0.07	0.3	1.3
4/13/94 0:00	572	270	#N\A	<5				
8/3/94 0:00	38	20	21.0		1.05	0.02		
11/4/94 0:00	143	72	9.2		1.62	0.21		
1/18/95 0:00	1090	499	0.8		0.99	-0.01	0.4	1.3
4/19/95 0:00	206	102	6.0		1.50	0.18		
7/26/95 0:00	61	32	22.0		1.73	0.24		
10/26/95 0:00	100	51	7.7		0.97	-0.01		
2/14/96 0:00	135	68	7.0		1.17	0.07	0.2	1.0
5/6/96 0:00	463	221	2.1		1.13	0.05		
8/20/96 0:00	49	26	11.0		0.70	-0.15		
10/11/96	116	59	7.3		1.06	0.02		
11/1/96	287	140	3.0		1.03	0.01		
12/13/96	410	**213**	2.0		1.04	0.02		
1/6/97	370	**157**	2.1		0.81	-0.09	0.3	1.0
1/9/97	223	**138**	3.1		1.05	0.02		
2/7/97	158	**66**	7.8		1.25	0.10		
2/19/97	144	**54**	8.7		1.15	0.06		
2/26/97	227	**76**	4.3		0.80	-0.10		
4/11/97	455	**344**	2.1		1.77	0.25		
5/6/97	404	**208**	2.7		1.37	0.14		
7/8/97	51	**22**	13		0.70	-0.15		
7/29/97	37	**18**	16		0.70	-0.15		
11/7/97		**61**	5.7		0.85	-0.07		
2/2/98	101	52	7.1		0.90	-0.05	0.1	0.9
4/16/98		**78**	4.2		0.81	-0.09		
[illegible]		65	[illegible]		[illegible]	[illegible]		
10/2/98	Measured same flow by VA Method 9/15/98	30	14		1.01	0.00		
11/10/98		54	6.2		0.82	-0.09		
2/1/99	[illegible]	127	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]
4/20/99	142	**76**	4.9		0.91	-0.04		
7/9/99	42	**23**	13.0		0.72	-0.14		
11/09/99	*150*	**82**	3.1	3.0 Dup	0.62	-0.21		
12/20/99	*120*	69	4.9		0.83	-0.08		
02/23/00	*110*	51	4.6	4.5 Dup	0.57	-0.25		
5/17/00		**114**	2.3		0.64	-0.19		

<5 Below detection limit of 5 µg/l

T Trace level detected at or below the detection limit

J Approximate value estimated below the detection limit

85 Flow rate determined from SME stage discharge curve and water elevation from Boiling Springs Station pressure transducer Other flow rates determined from relationship with historical record at USGS Yarmouth Station (updated 9/98)

110 Estimated flow rate from USGS real-time data download, data not considered official.

23 Flow rate determined by SME [illegible] measurements

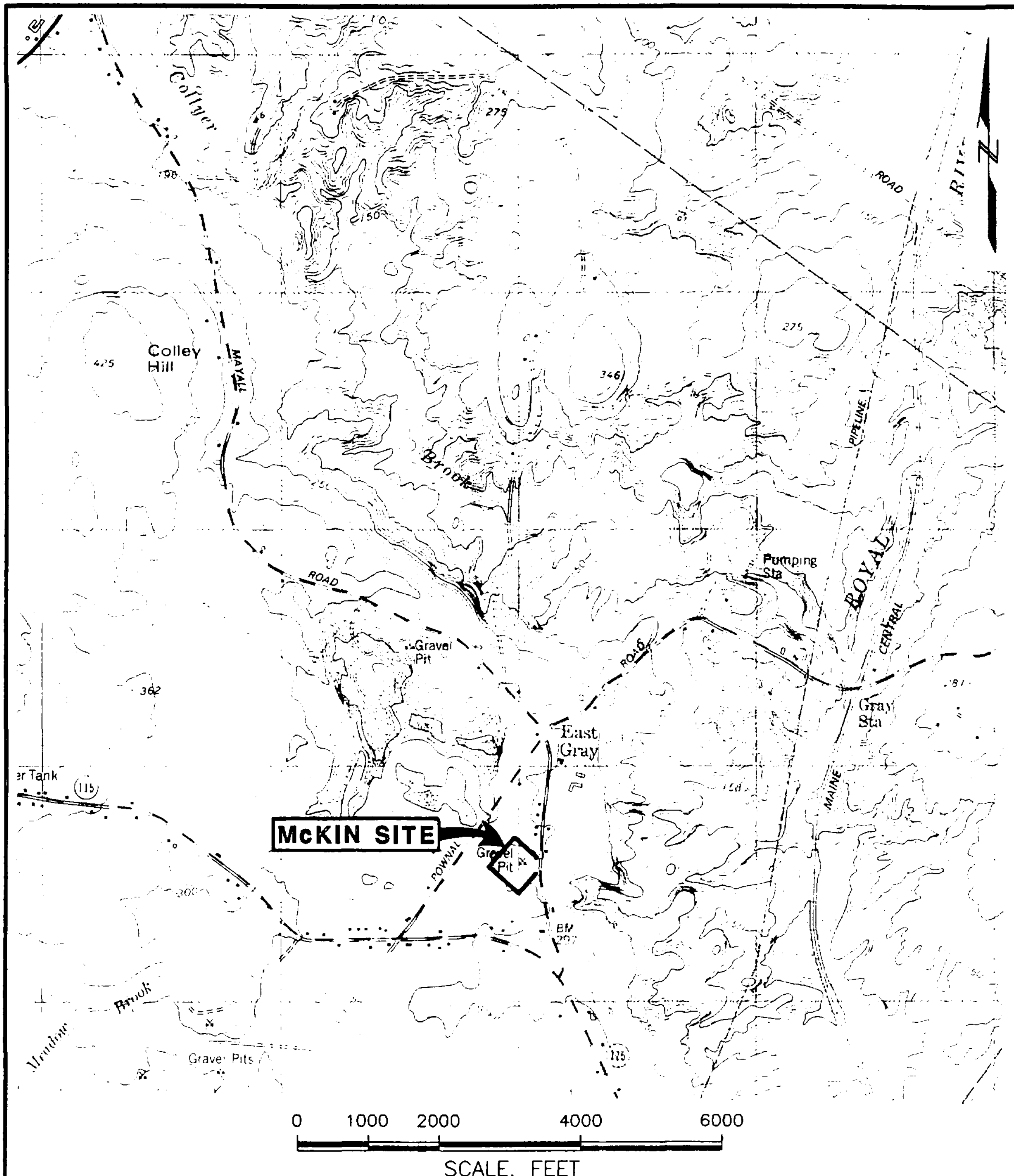
Loading Rate (kg/day) = Q * TCE Concentration * 7.48 * 60 * 60 * 24 * (1/1000000000) * 3.7854

Loading rate (gallons/year) = Q * TCE Concentration * 7.48 * 60 * 60 * 24 * 365*(0.000000001) * 3.7854 * (.001) * (.7072) * 264.172

MCKIN SUPERFUND SITE

GRAY, MAINE

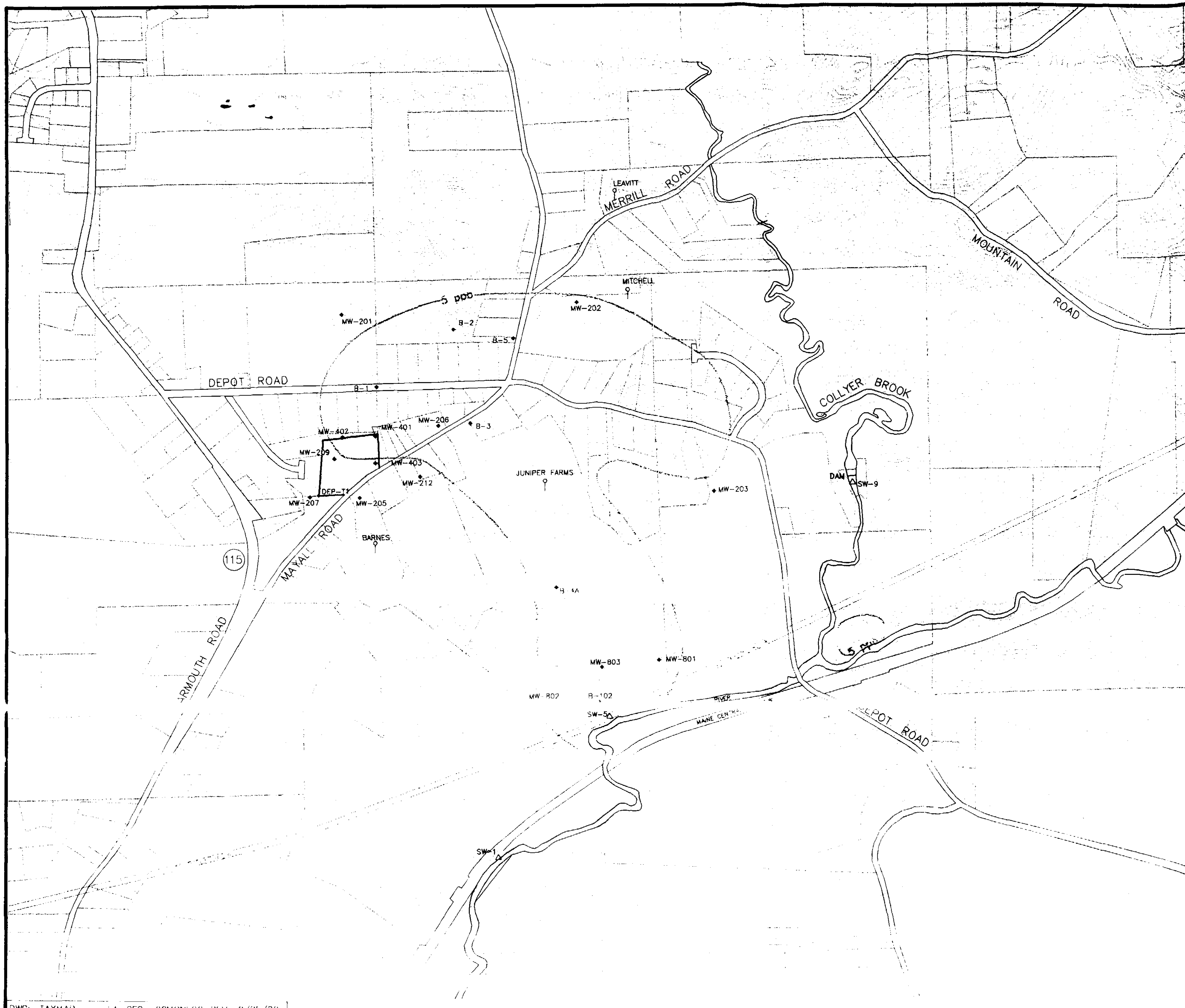
FIGURES



Map is taken from U.S.G.S. Topographic 7.5 Minute Series Gray, Maine Quadrangle, 1980.
Datum is National Geodetic Vertical Datum (NGVD).
Contour Interval is 10 Feet.

McKin PRP Technical Committee	Technical Impracticability Evaluation McKin Superfund Site Gray, Maine	Figure 1: Site Location Map
GEI Consultants, Inc.	Project 95248	

95248-06 5/30/95 PTC



NOTES

BASE MAP FEATURES PROVIDED BY THE TOWN OF GRAY.
GROUND SURFACE CONTOURS PROVIDED BY CASCO BAY ESTUARY PROJECT.
EXPLORATIONS SURVEYED BY SQUAW BAY CORP.

LEGEND

5 ppb — 5 PPB TCE CONTOUR IN SOIL OVERBURDEN GROUNDWATER, INTERPRETED IN NOVEMBER 1998

MW-801 — EXISTING MONITORING WELL OR WELL CLUSTER

SW-1 — SURFACE WATER SAMPLING POINTS

BARNES — SEEP OR SPRING SAMPLING POINTS

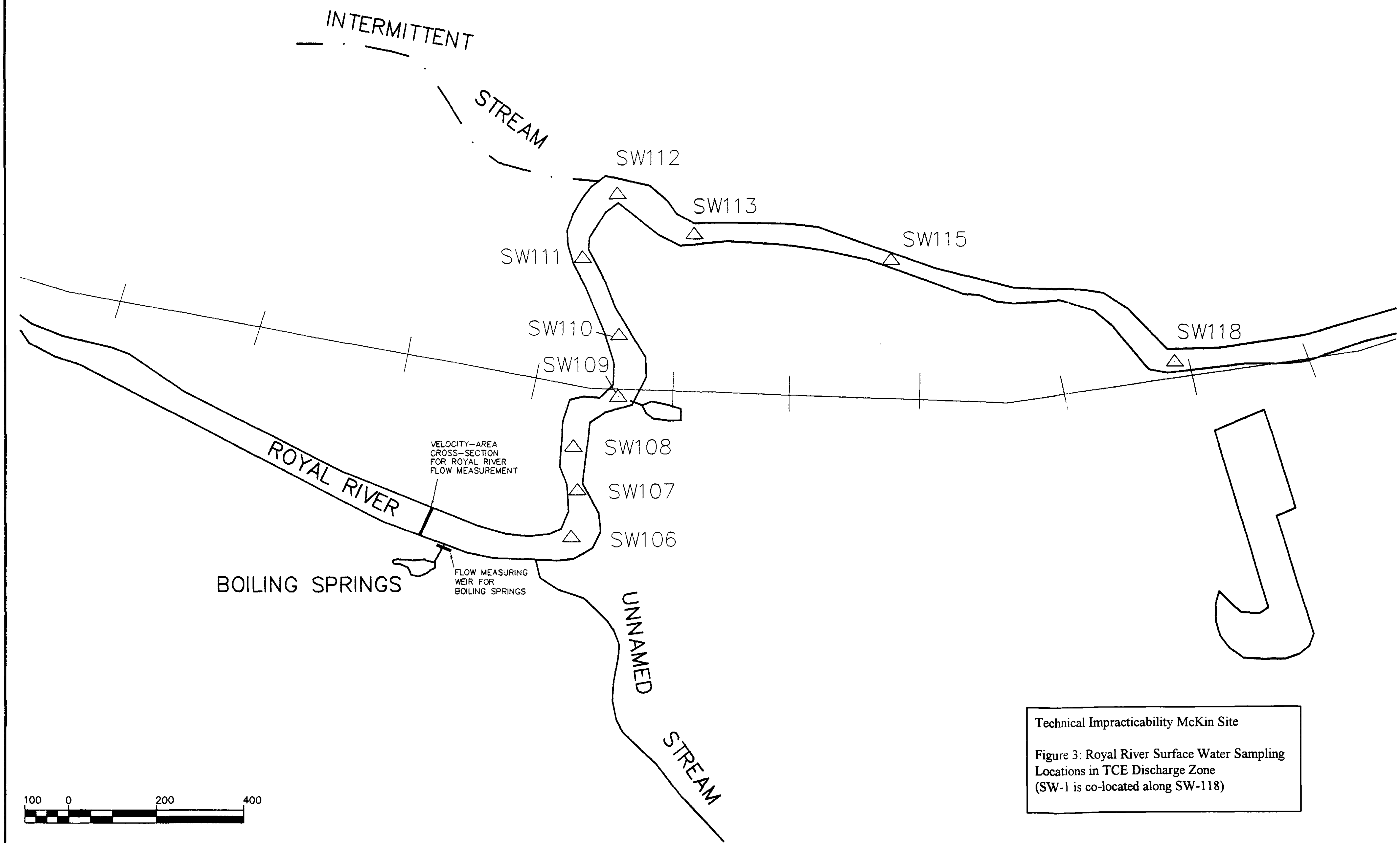
500 0 1000 2000

Technical Impracticability
McKin Site

Figure 2: Overburden Plume Map

SME
Sevee & Maher Engineers, Inc.

DWG: TAXMAP A. CFG. 99MONLOC REV. 2/25/99



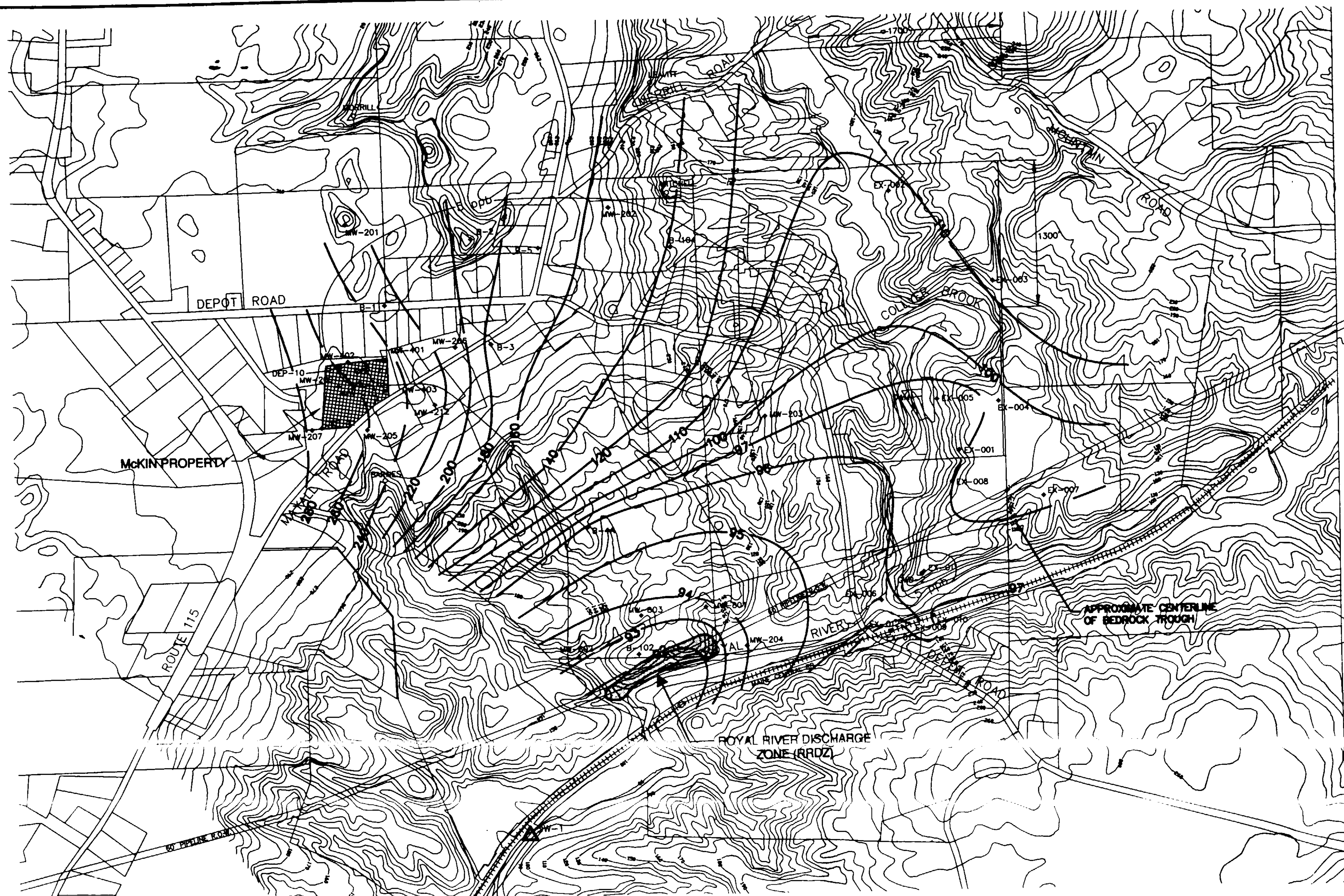
Technical Impracticability McKin Site

Figure 3: Royal River Surface Water Sampling Locations in TCE Discharge Zone (SW-1 is co-located along SW-118)

DWG:MCKQUAD3 LA. CFG. FEB97 REV. 8/97

SEVEE & MAHER ENGINEERS, INC.

D: \MCK\ACAD\QUAD\MCKQUAD3.DWG Wed Aug 13 11:08:23 1997



NOTES (FROM SME PLAN - SEE THIS PLAN'S NOTE 1):

BASE MAP FEATURES PROVIDED BY THE TOWN OF GRAY. GROUND SURFACE CONTOURS PROVIDED BY CASCO BAY ESTUARY PROJECT. EXPLORATIONS SURVEYED BY SQUAW BAY CORP.

INTERPRETATION OF POTENTIOMETRIC SURFACE ELEVATION CONTOURS BASED ON WATER LEVEL MEASUREMENTS MADE MAY 1998. ACTUAL CONFIGURATION OF POTENTIOMETRIC SURFACE MAY VARY FROM THAT SHOWN. POTENTIOMETRIC SURFACE VARIES WITH SEASON AND PRECIPITATION.

LEGEND

—5 ppb—	5 PPB TCE CONTOUR IN OVER-BURDEN GROUNDWATER, INTERPRETED IN NOVEMBER 1998
—120—	INTERPRETED SOIL OVERBURDEN GROUND-WATER POTENTIOMETRIC SURFACE CONTOUR IN FEET-NGVD, MAY 1998
MW-801	EXIST. MONITORING WELL OR WELL CLUSTER
SW-1	SURFACE WATER SAMPLING POINT

Technical Impracticability
McKin Site

Figure 4: Royal River Discharge Zone

NOTE:

1. BASE MAP SOURCE: PLAN BY SEVEE & MAHER ENGINEERS, INC., ENTITLED: "LOCATION MAP PROPOSED INSTITUTIONAL CONTROL ZONE MONITORING WELLS McKIN SITE GRAY, MAINE", REV. 12/4/98.

GRAPHIC SCALE

0' 1000' 2000'

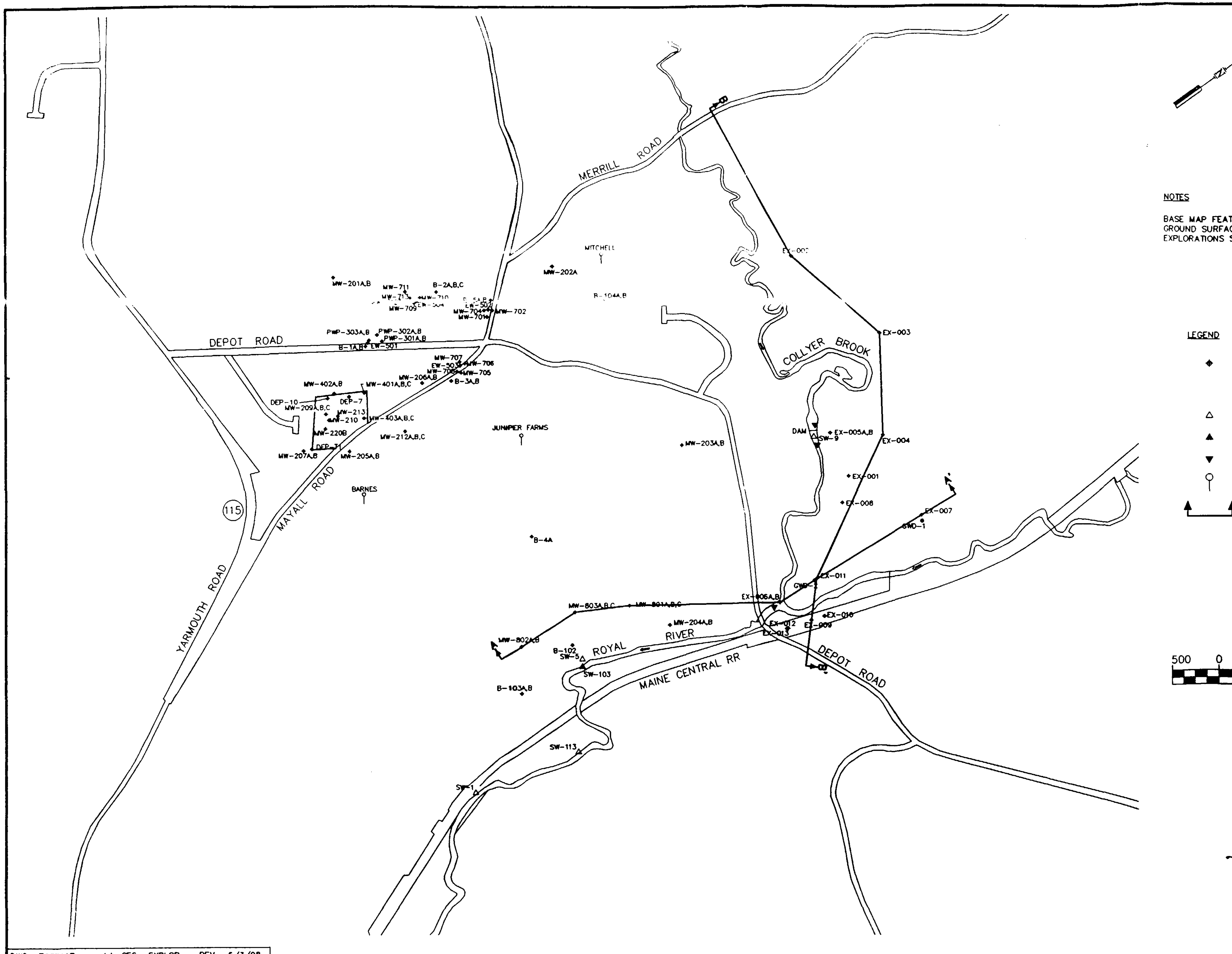
1 INCH = 1000 FEET

ROYAL RIVER DISCHARGE ZONE FEASIBILITY STUDY

McKIN SITE - GRAY, MAINE

DRAWN BY:	R.G. DEWSNAP	REV.:	0
CHECKED BY:	J. FORRELLI	DATE:	04 AUG 99
SCALE:	1" = 1000'	FILE NO.:\DWG\McKIN_1\FEAS_STDY\SITE_MAP_1.DWG	

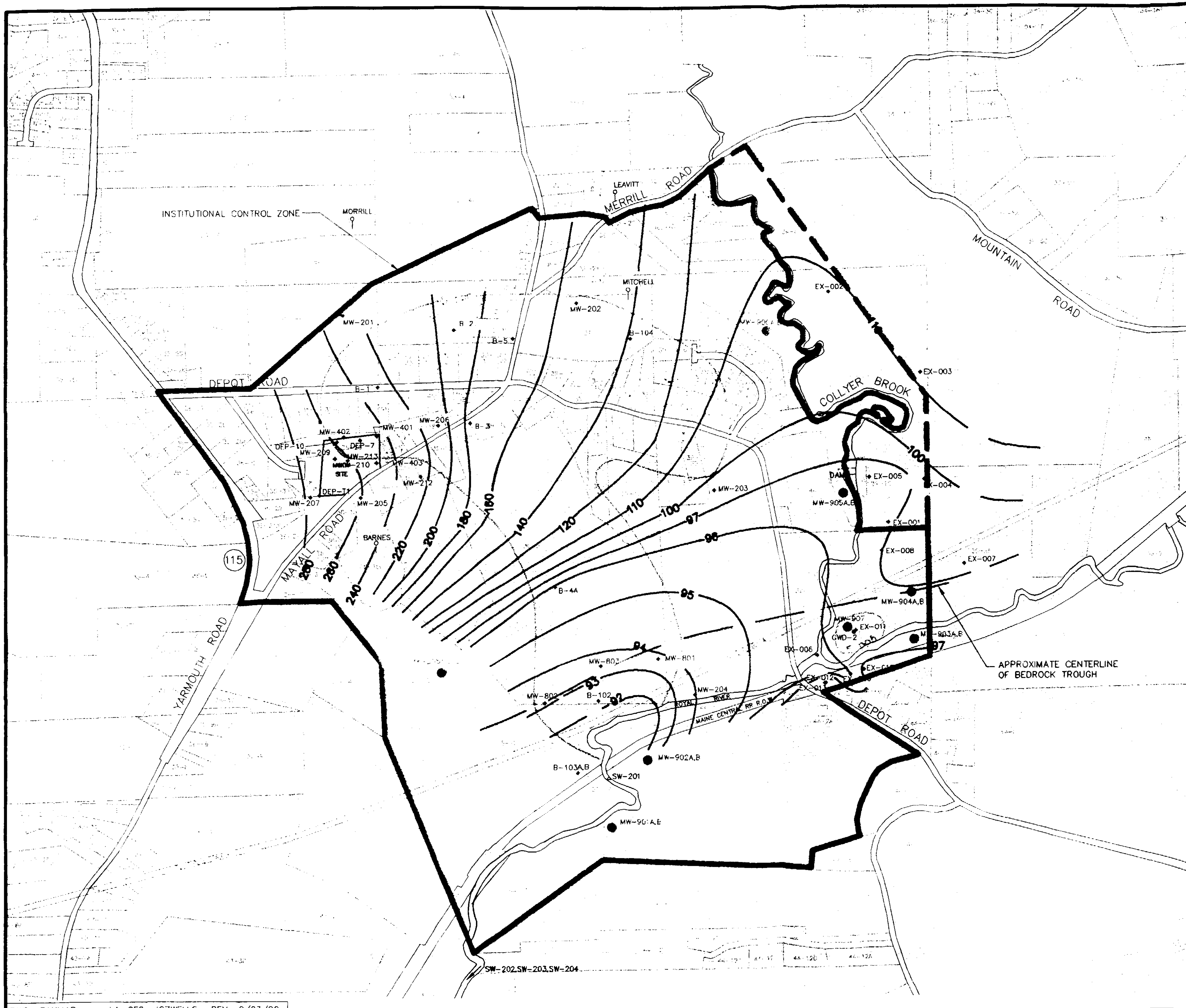
TETRA TECH NUS, INC.
55 Jonspin Road Wilmington, MA 01887
(978)658-7899



Technical Impracticability
McKin Site

Figure 5: Gray Depot Area Investigation

SME
Sevee & Maher Engineers, Inc.



NOTES

BASE MAP FEATURES PROVIDED BY THE TOWN OF GRAY.
GROUND SURFACE CONTOURS PROVIDED BY CASCO BAY ESTUARY PROJECT.
EXPLORATIONS SURVEYED BY SQUAW BAY CORP.

INTERPRETATION OF POTENTIOMETRIC SURFACE ELEVATION CONTOURS BASED ON WATER LEVEL MEASUREMENTS MADE MAY 1998. ACTUAL CONFIGURATION OF POTENTIOMETRIC SURFACE MAY VARY FROM THAT SHOWN.
POTENTIOMETRIC SURFACE VARIES WITH SEASON AND PRECIPITATION.

LEGEND

MW-901 PROPOSED LOCATION FOR INSTITUTIONAL CONTROL ZONE GROUNDWATER MONITORING WELL

INSTITUTIONAL CONTROL ZONE BOUNDARY

5 PPB TCE CONTOUR IN SOIL OVERBURDEN GROUNDWATER, INTERPRETED IN NOVEMBER 1998

120 INTERPRETED SOIL OVERBURDEN GROUNDWATER POTENTIOMETRIC SURFACE CONTOUR IN FEET NGVD, MAY 1998

SUGGESTED ALTERNATE INSTITUTIONAL CONTROL ZONE BOUNDARY

SEEP OR SPRING SAMPLING POINTS

MW-801 EXISTING MONITORING WELL OR WELL CLUSTER

SW-201 SURFACE WATER SAMPLING POINTS

RANGE OF REGIONAL BEDROCK FOLIATION

500 0 1000 2000 FEET

Technical Impracticability
McKin Site

Figure 6: Institutional Control Zone

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G:\McK\GWD\ACAD\Taxmap.dwg Thu Feb 25 11:42:30 1999

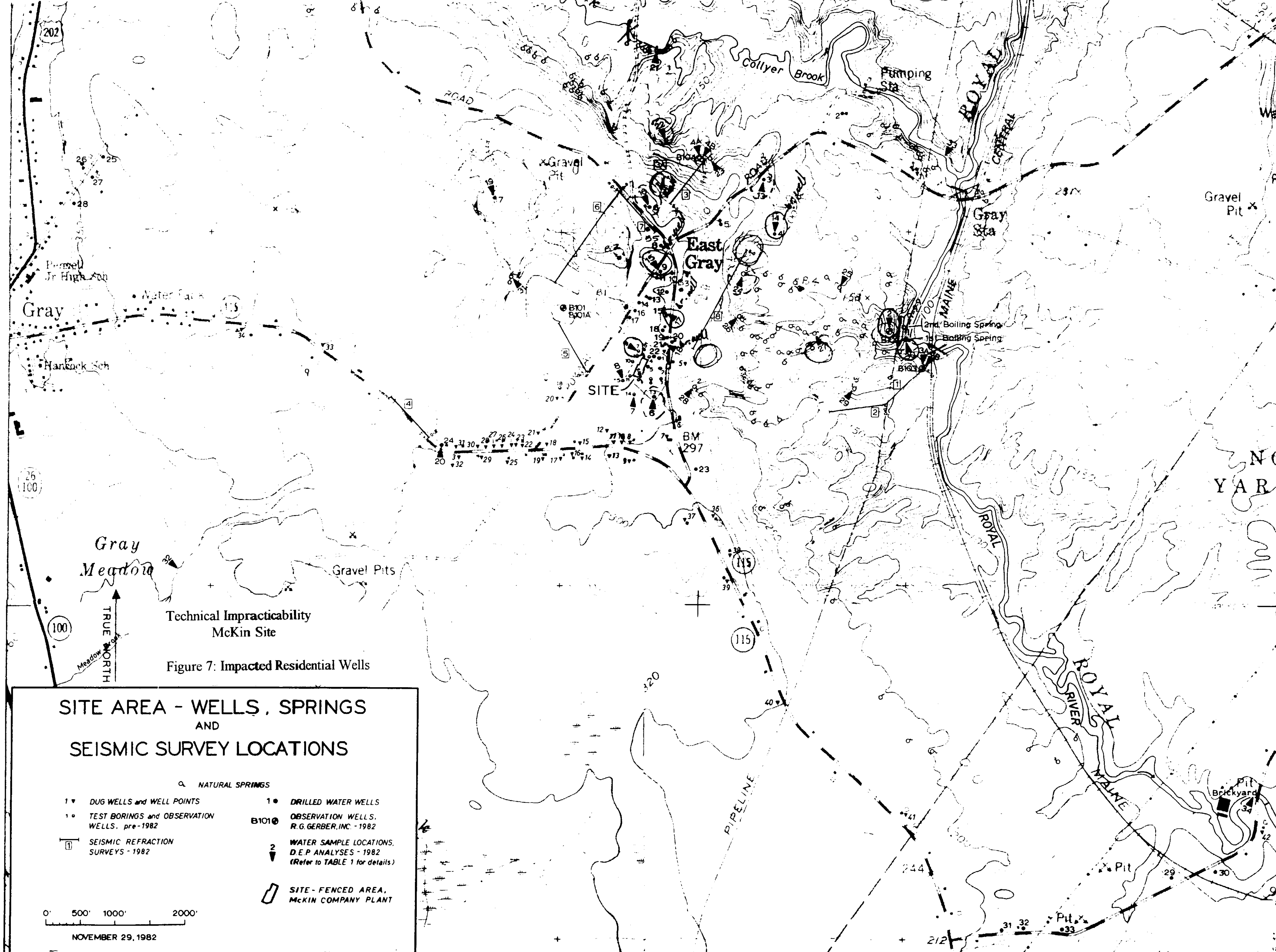

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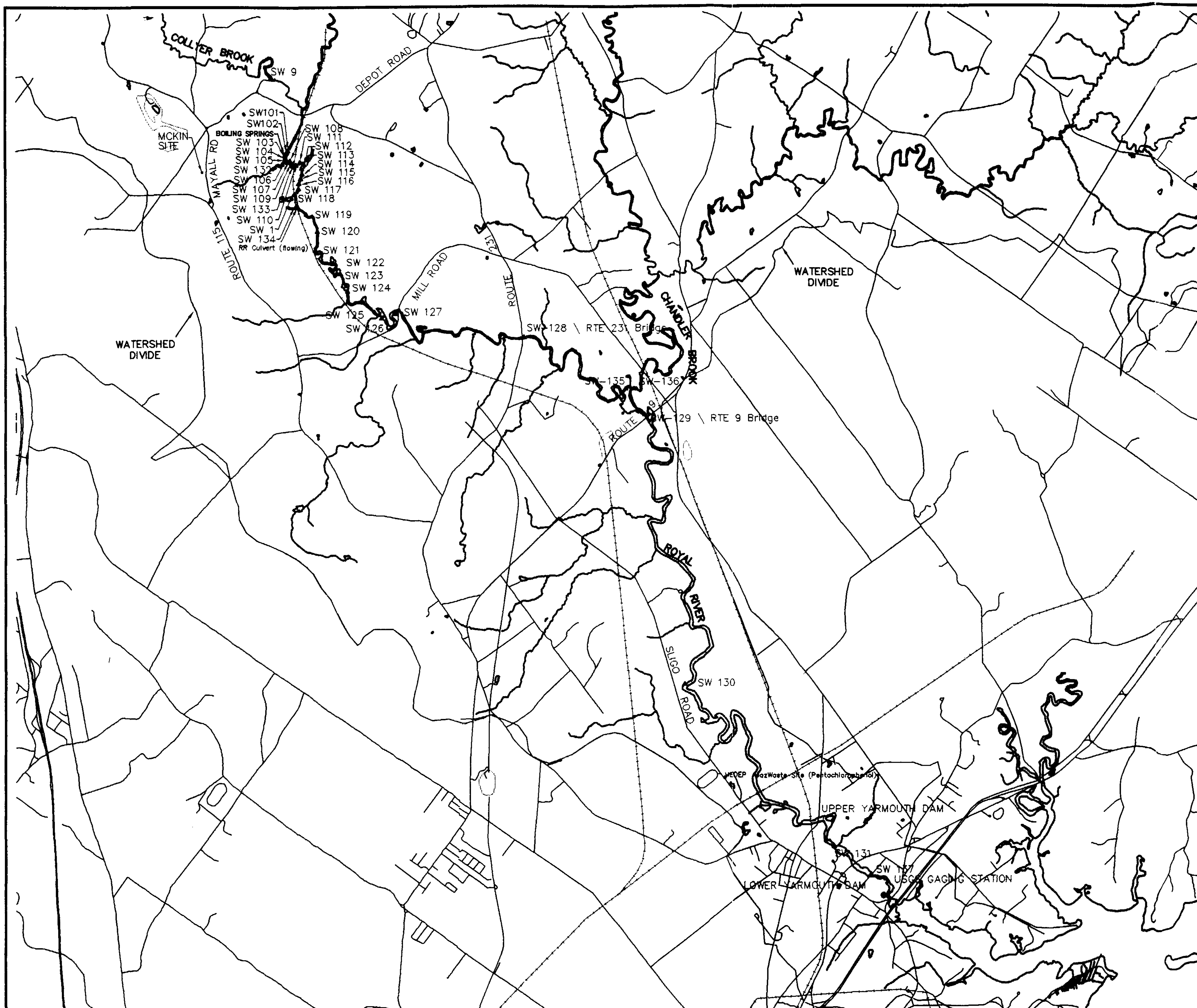
Figure 7: Impacted Residential Wells

D:\MCK\ACAD\QUAD\MCKQUAD3.DWG Wed Aug 13 09:43:58 1997



NOTES:

1. PLAN INFORMATION FROM DIGITAL 1:24,000 SCALE QUADRANGLE MAPS DERIVED FROM THE UNITED STATES GEOLOGICAL SURVEY MAPS GRAY, NORTH POWNAL, CUMBERLAND CENTER, AND YARMOUTH, MAINE. DIGITAL DATA PROVIDED BY MAINE STATE OFFICE OF GEOGRAPHIC INFORMATION SYSTEMS.

1000 0 2000 4000 FEET

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Figure 8: Downstream Royal River Surface Water Sampling Locations

DWG. MCKQUAD3.DWG LA. CFG. JANFEB97 REV. 8/97

SEVEE & MAHER ENGINEERS, INC.

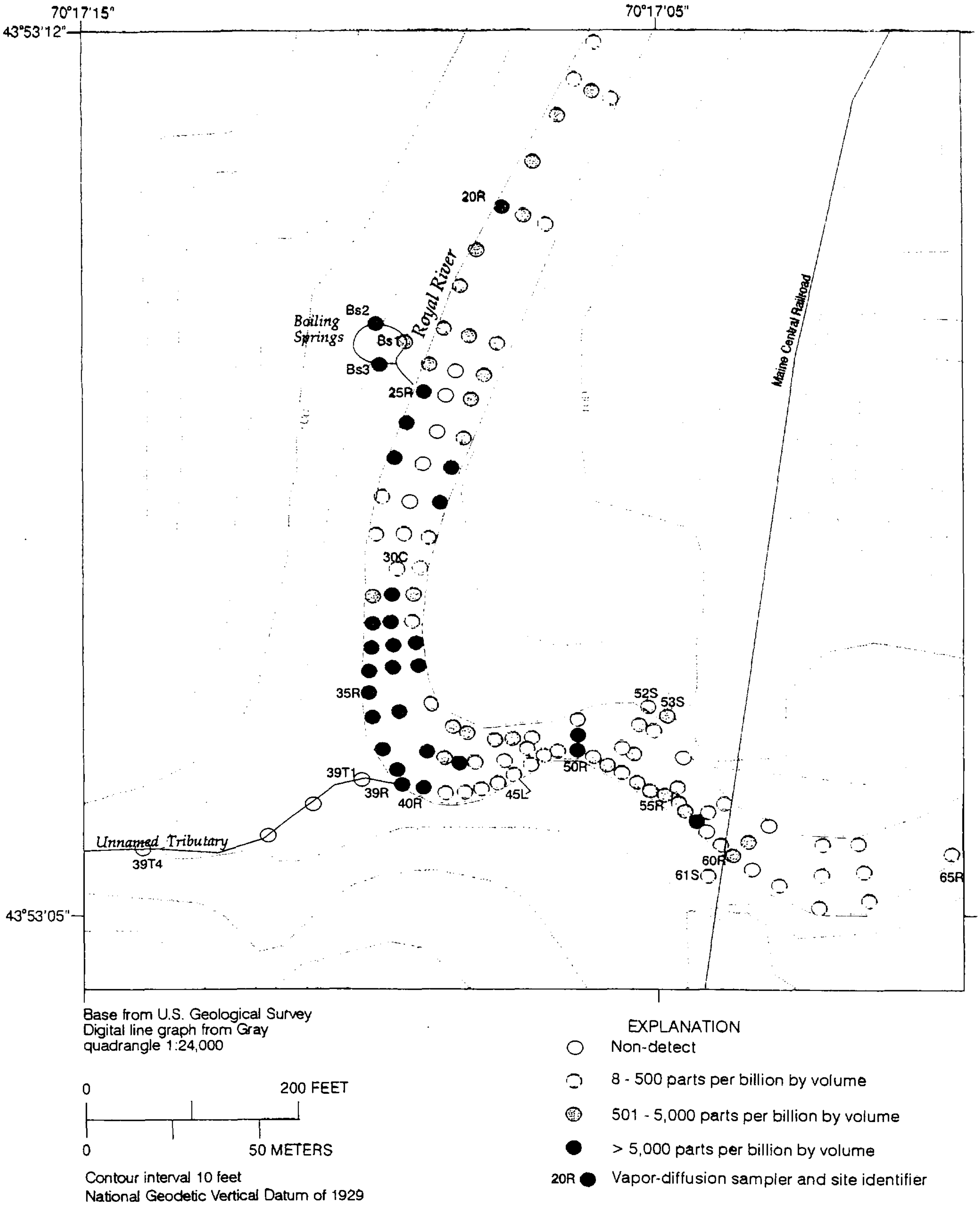

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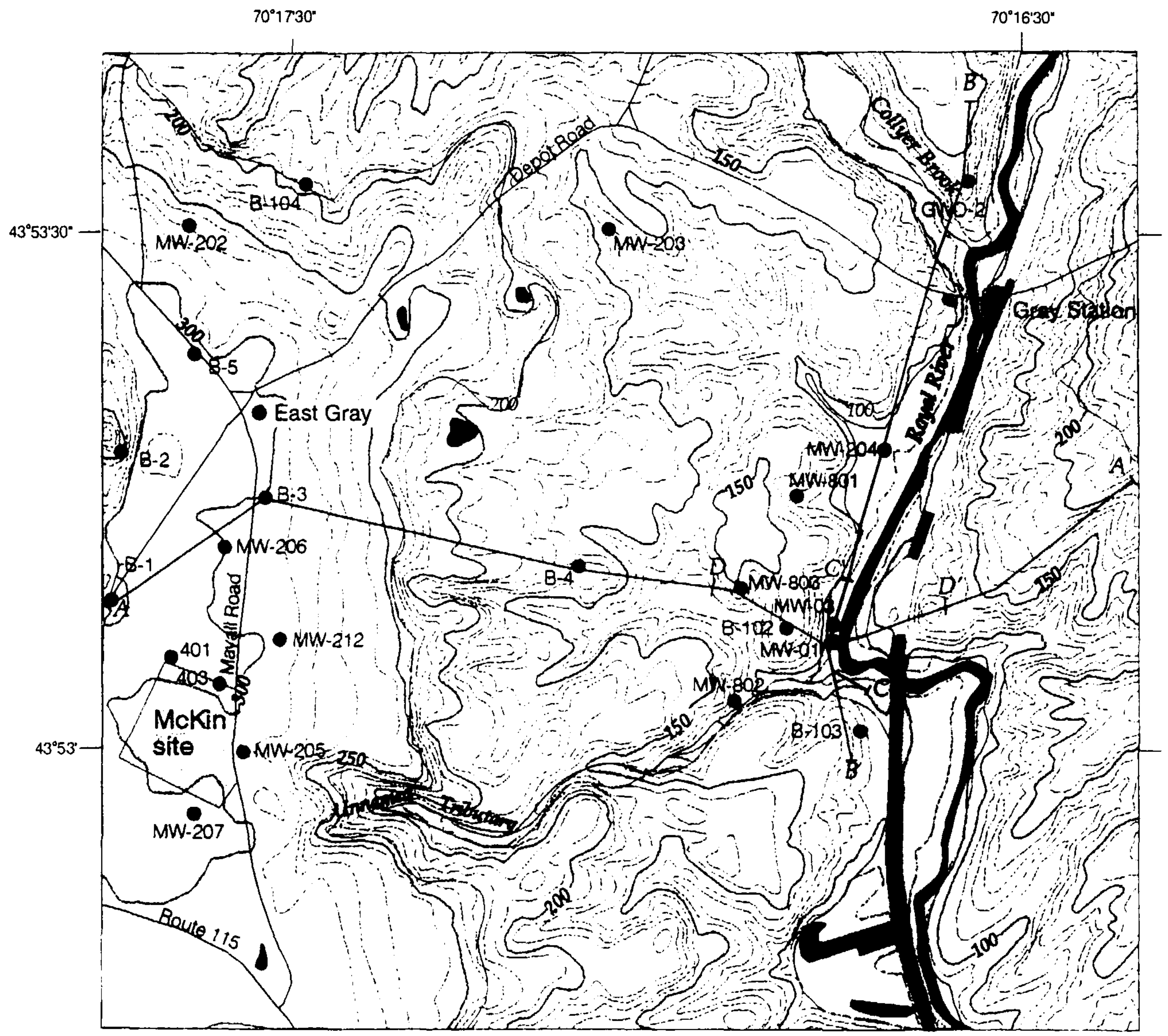
Figure 9: Distribution of TCE in Royal River

Original includes color coding.



Base from U.S. Geological Survey
Digital line graph from Gray
quadrangle 1:24,000

Geology modified from Weddle (1997)

0 500 1,000 FEET

0 100 200 300 METERS

Contour interval 10 feet
National Geodetic Vertical Datum of 1929

Surficial geology near the McKin Superfund Site.

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Figure 10: Surficial Geology

EXPLANATION

POSTGLACIAL DEPOSITS

Flood Plain Alluvium-- Silt, sand and gravel, with variable amounts of organic material on the flood plains of the Royal River, Collyer Brook, and the Unnamed Tributary; deposits are 10-12 ft thick along the Royal River, thinner along smaller streams; alluvium overlies thicker glacial materials in most places.

GLACIAL DEPOSITS

Glaciomarine Deposits, fine-grained -- Massive to finely laminated, gray silty clay with minor amounts of fine sand and sparse fossil marine mollusk shells and ice-rafted dropstones; deposited in the deeper water glaciomarine environment, distal from the ice margin. Where sediment has been oxidized in the upper part of section, the color is dark olive gray. This unit is the Presumpscot Formation of Bloom (1960;1963). In some places the upper 5-10 ft of unit is finely laminated to massive, silty fine to medium sand; deposited in the shallow glaciomarine environment during regression of the sea.

Glaciomarine Deposits, coarse-grained-- Well to poorly sorted gravel, sand and gravel, sand, and local diamict sediment laid down as deltaic and subaqueous fan deposits in contact with the glacier margin during retreat of the ice sheet in the glacial sea. Deposits are coarse-grained, poorly sorted, and bedding is collapsed in ice-proximal (northerly) parts; sediments are finer grained, better sorted, and beds generally dip southerly farther from (distal to) the ice-margin position; in distal parts of the deposits, fan and delta sediments interfinger with fine-grained glaciomarine sediments. Coarse-grained fan deposits are present beneath fine-grained deposits in much of the area west of the McKin Superfund Site.

Glacial Till-- Nonsorted and nonstratified, compact mixture of grain sizes ranging from clay to large boulders; matrix is largely fine sand containing up to 25 percent silt and clay; deposited beneath glacial ice. Locally, a less compact, sandy, stony facies of till may overlie the more compact facies. In the map area, till is present at land surface in only two small areas; it forms a thin blanket over bedrock in most places in the subsurface.

MAP SYMBOLS

Contact between map units

A A' Location of geologic section line; section shown in figures 4 and 5

● MW-802 Location of wells and test borings; numbers as reported in Sevee and Maher, Engineers Inc., 1998

Waterbodies

Original includes color coding.

Artificial fill of railroad and road embankments

Surficial geology near the McKin Superfund Site—Continued.

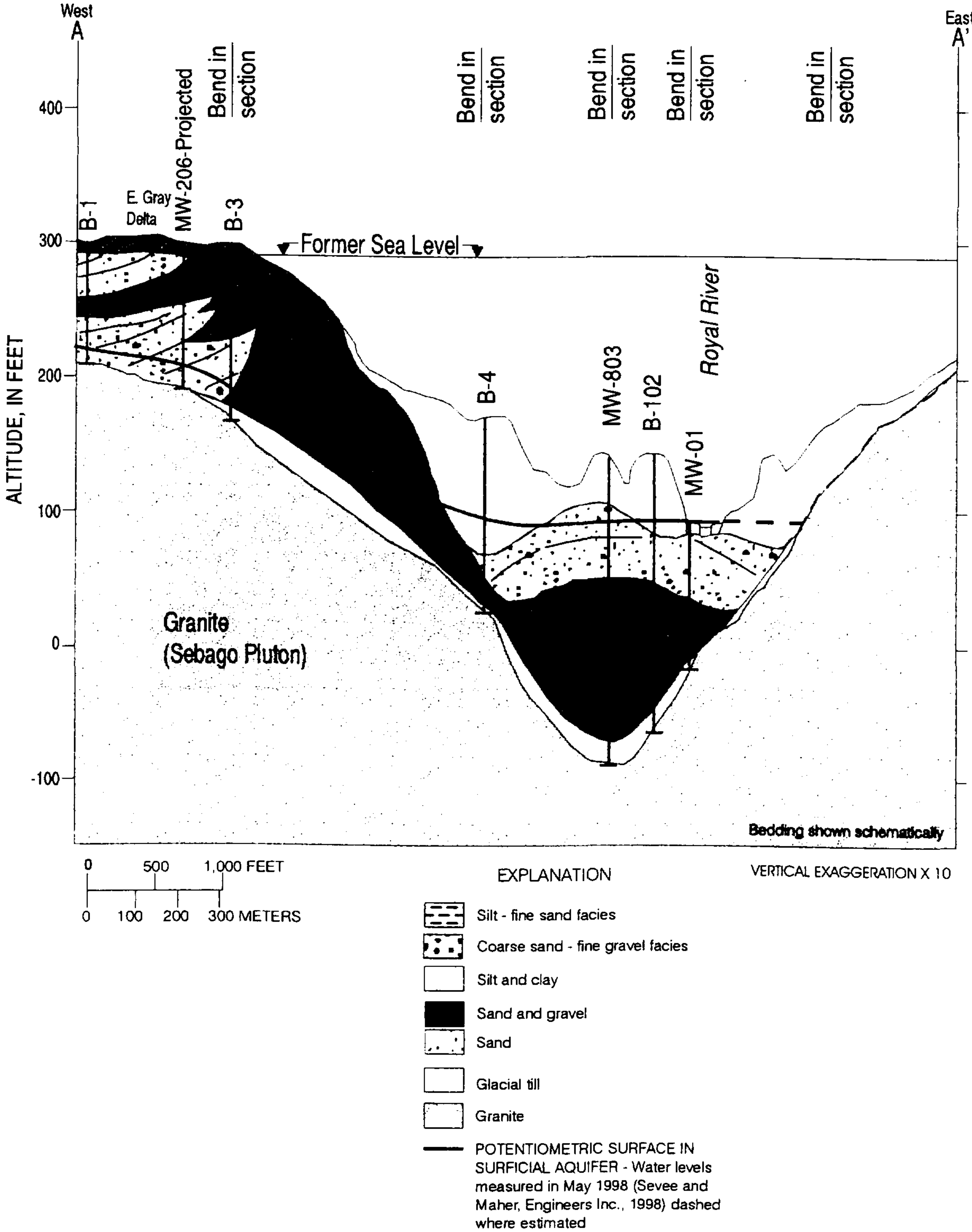

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Figure 11: Geologic Cross-Section

Original includes color coding.

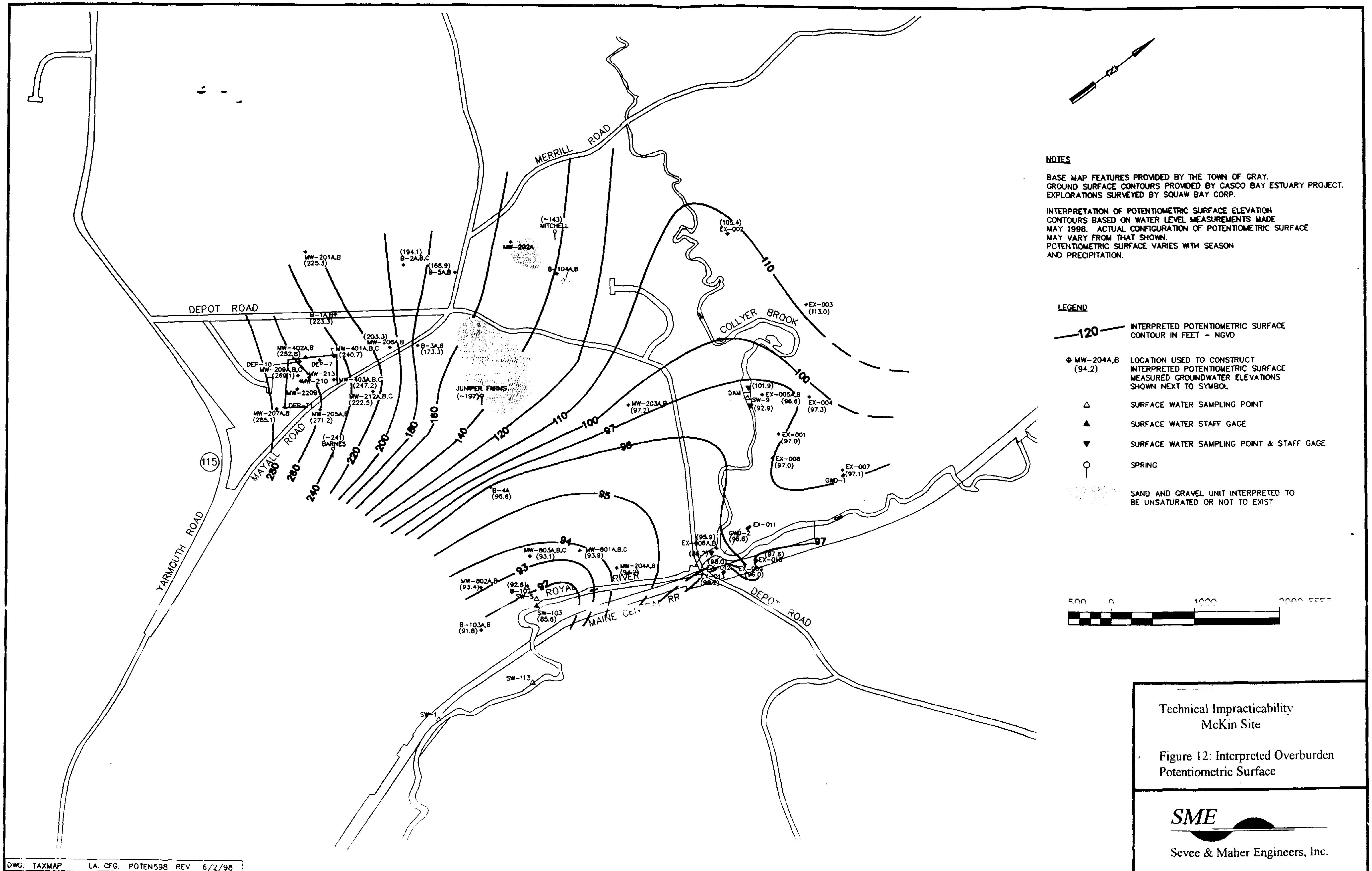

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Figure 12: Interpreted Overburden Potentiometric Surface

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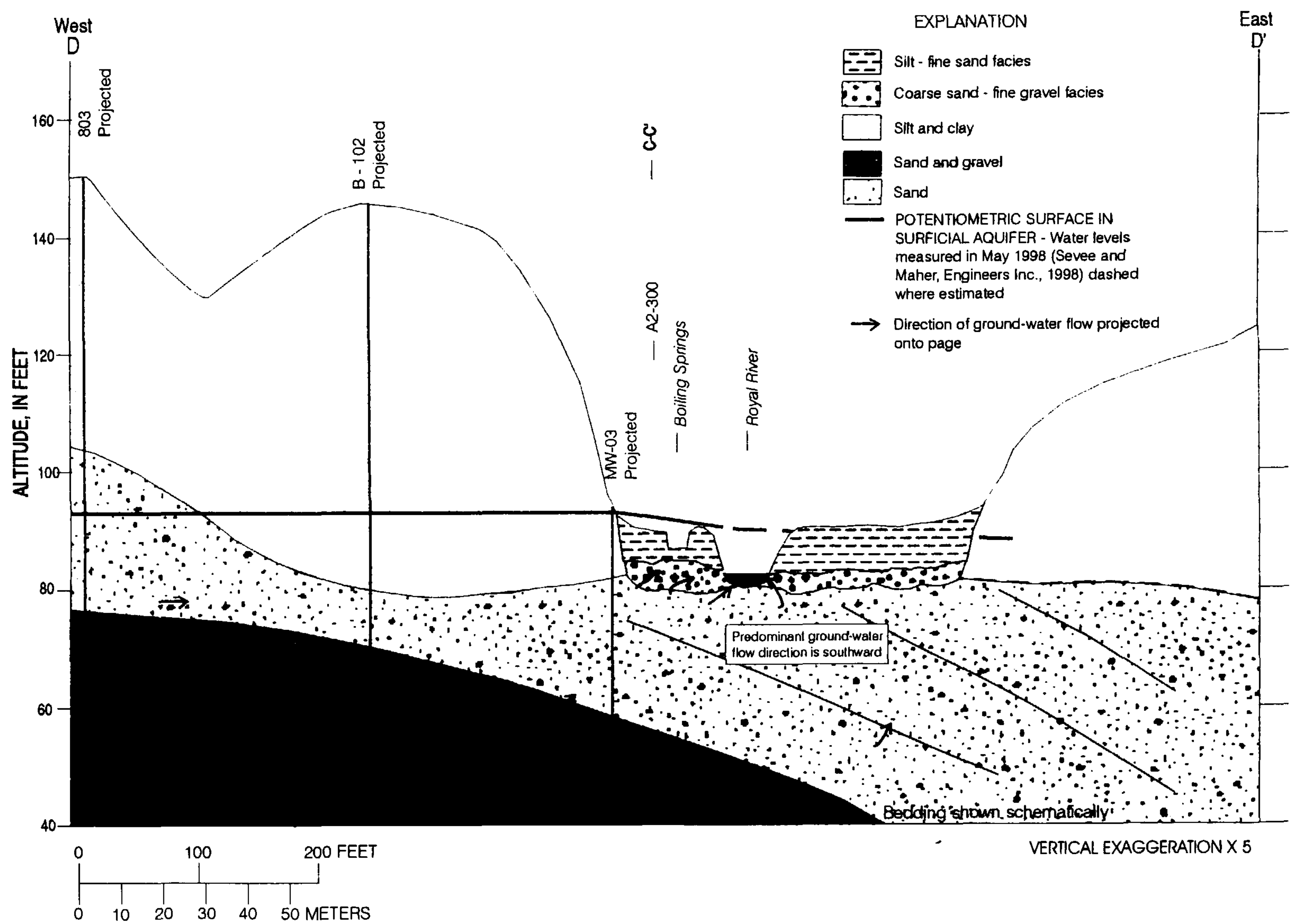

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Figure 13: Geologic Cross-Section near Boiling Springs. (Location of section line shown on Figure 10)

Original includes color coding.

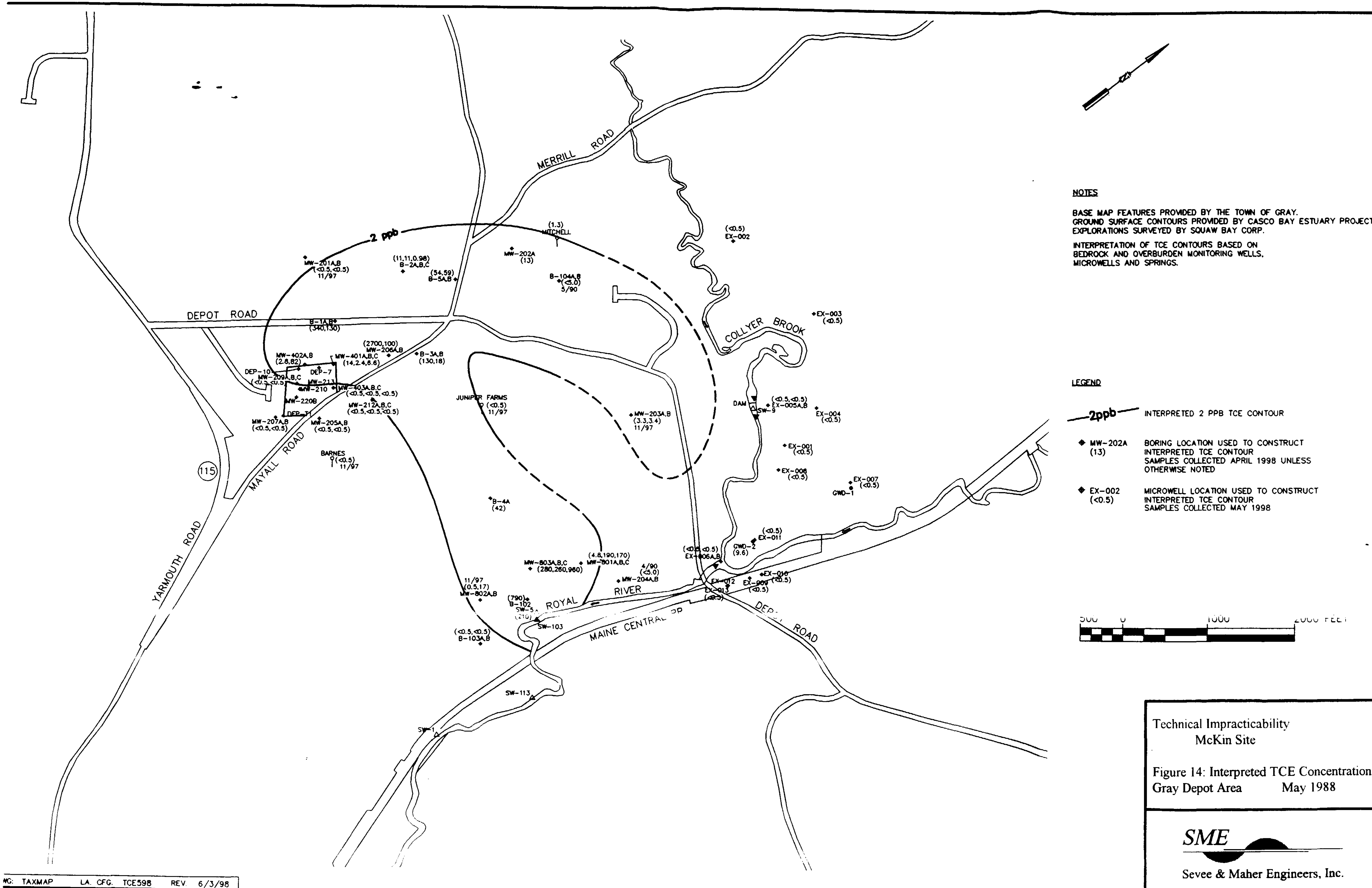

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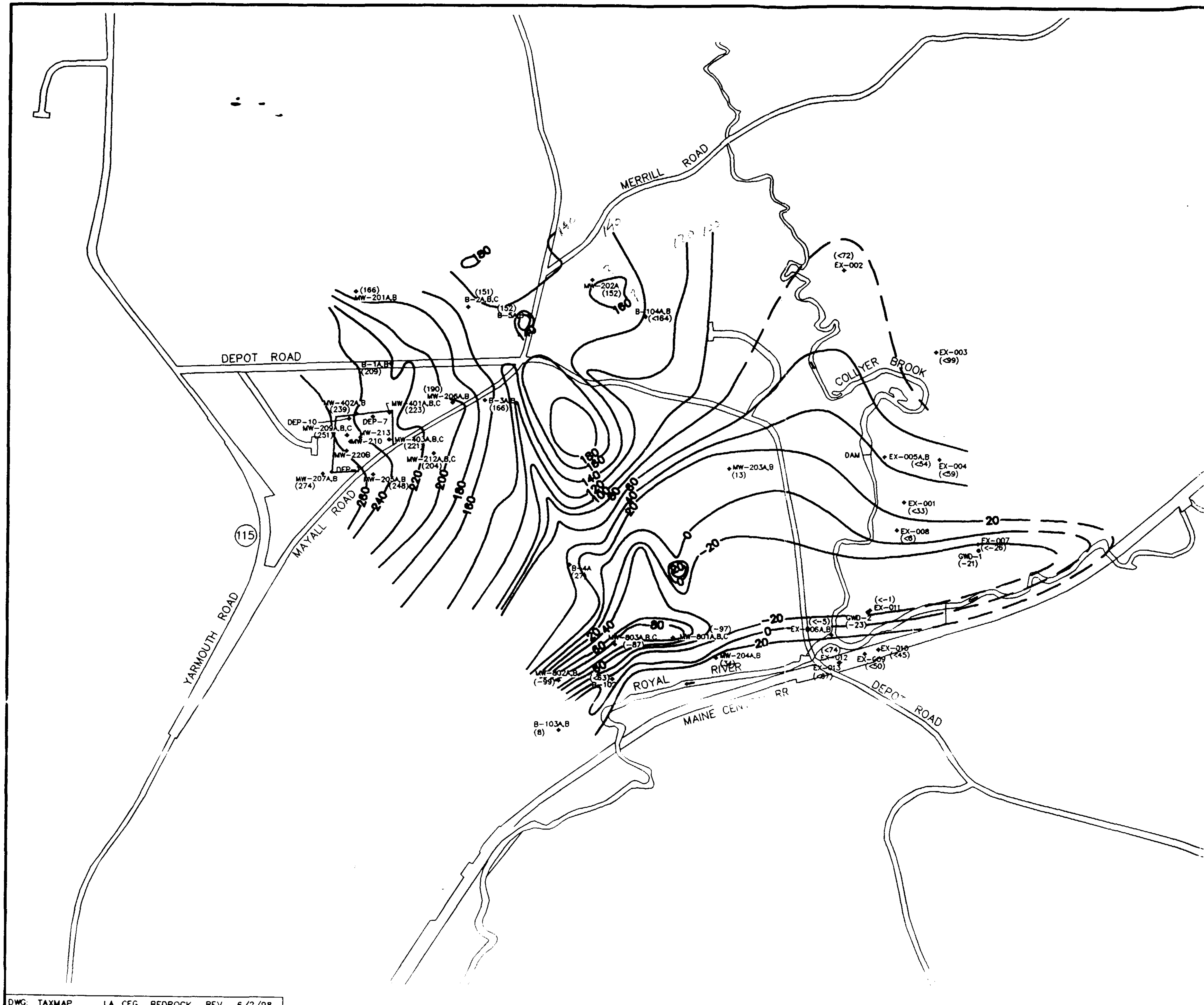
Figure 14: Interpreted TCE Concentrations
Gray Depot Area May 1988

SME
Sevee & Maher Engineers, Inc.



NOTES

BASE MAP FEATURES PROVIDED BY THE TOWN OF GRAY.
GROUND SURFACE CONTOURS PROVIDED BY CASCO BAY ESTUARY PROJECT.
EXPLORATIONS SURVEYED BY SQUAW BAY CORP.

INTERPRETATION OF BEDROCK ELEVATION CONTOURS BASED ON BORINGS, SEISMIC REFRACTION SURVEY, AND OUTCROP OBSERVATION. ACTUAL CONFIGURATION OF BEDROCK SURFACE MAY VARY FROM THAT SHOWN. THE BEDROCK SURFACE CONTOURS SHOULD BE USED ONLY FOR INDICATING GENERAL TRENDS IN THE BEDROCK SURFACE.

LEGEND

120	INTERPRETED BEDROCK SURFACE CONTOUR IN FEET – NGVD
◆ MW-202A (152)	BORING LOCATION USED TO CONSTRUCT INTERPRETED BEDROCK SURFACE MEASURED ELEVATION OF BEDROCK SURFACE AT BORING LOCATION SHOWN NEXT TO SYMBOL
● EX-002 (<72)	MICROWELL LOCATION USED TO CONSTRUCT INTERPRETED BEDROCK SURFACE
<	INDICATES BEDROCK SURFACE AT THIS ELEVATION OR LOWER

500 0 1000 2000 FEET

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McKin Site

Figure 15: Interpreted Bedrock Surface

SME
Sevee & Maher Engineers, Inc.

DWG: TAXMAP LA. CFG. BEDROCK REV. 6/2/98

LEGEND

SILT AND FINE SAND - MOSTLY SILT AND VERY FINE SAND WITH PLANT FRAGMENTS

SAND AND FINE GRAVEL - MOSTLY COARSE TO VERY COARSE SAND AND FINE GRAVEL WITH PLANT FRAGMENTS

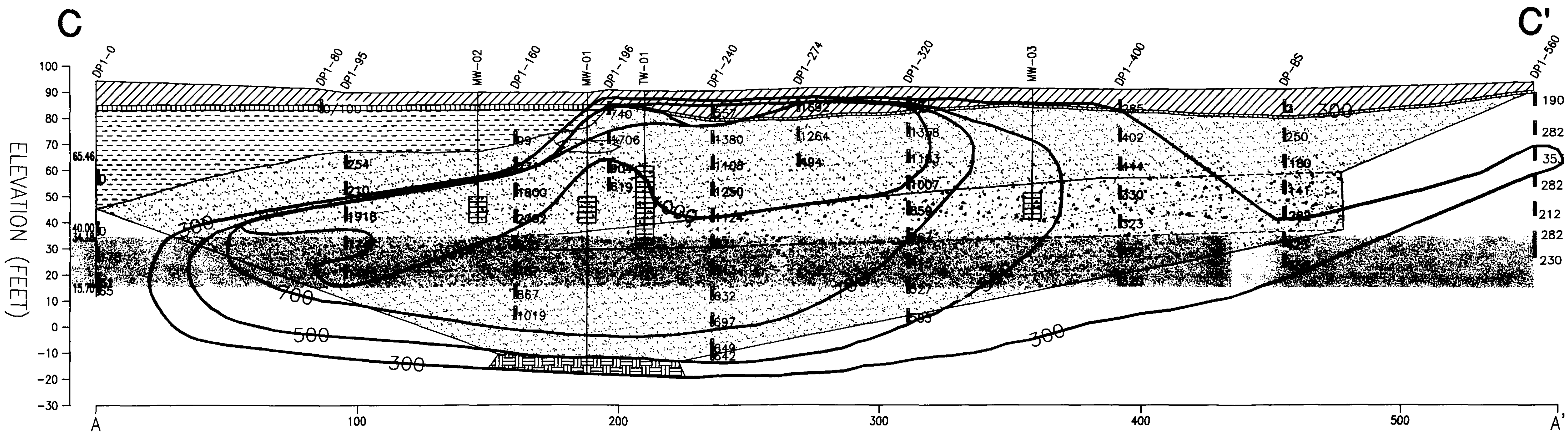
CLAY AND SILT - LARGELY BLUE-GREY DEPOSITS OF SILT AND CLAY WITH MINOR FINE SAND. CLAY IS OFTEN CHARACTERIZED BY HIGH PLASTICITY. THESE DEPOSITS LIKELY REPRESENT THE PRESUMPSCOT FORMATION.

SAND - WIDELY GRADED SAND WITH MINOR SILT AND GRAVEL. COLOR IS LIGHT BROWN TO LIGHT GRAY. DENSITY IS GENERALLY LOOSE.

SAND AND GRAVEL - WIDELY GRADED SAND WITH FINE GRAVEL. COLOR IS GENERALLY LIGHT BROWN.

BEDROCK - CHIPS GENERATED BY DRILLING SHOW A MINERAL ASSEMBLAGE OF QUARTZ-FELDSPAR-BIOTITE-MUSKOVITE, SUGGESTING A GRANITIC LITHOLOGY.

CALCULATED AREA* BETWEEN ISOCON LINES (SQ.FT.)	
300-500	11,870
500-700	6,845
700-1000	10,206
>1000	6,603



LEGEND

DP1-95 DIRECT PUSH TECHNOLOGY (DPT) WELL POINT LOCATION (WITH IDENTIFIER)

MW-02 SOIL BORING LOCATION (WITH IDENTIFIER)

WELL SCREEN LOCATION

180 GROUNDWATER SAMPLE DEPTH WITH TCE FIELD SCRENING CONCENTRATION (ppb) ADJUSTED FROM COMPARISON OF CLP DATA VS. FIELD GC DATA. THE COMPARISON GENERATED A MULTIPLIER OF 1.41.

1250 GROUNDWATER SAMPLE DEPTH WITH TCE CONCENTRATION (ppb) CLP ANALYSIS (U= NOT DETECTED, * = AVERAGE OF DUPLICATE SAMPLE)

300 TCE CONCENTRATION CONTOUR (PPB)

LITHOLOGIC BOUNDARY (DASHED WHERE INFERRED)

SHALLOW CONFINED AQUIFER ZONE - OBSERVATION WELLS COMPLETED IN THE ZONE USED TO DRAW POTENTIOMETRIC SURFACE IN THE SHALLOW CONFINED AQUIFER

DEEP CONFINED AQUIFER ZONE - OBSERVATION WELLS COMPLETED IN THE ZONE USED TO DRAW POTENTIOMETRIC SURFACE IN THE DEEP CONFINED AQUIFER

NOTES:

1. ALL LOCATIONS ARE TO CONSIDERED APPROXIMATE.
2. PLAN IS NOT TO BE USED FOR DESIGN.
*3. AREAS CALCULATED BY AUTOCAD BASED ON THE DEPICTED ISOCON LINES.

GRAPHIC SCALE

0' 40' 80'

1 INCH = 40 FEET

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Figure 16: Royal River Discharge Zone TCE Plume Profile

ROYAL RIVER DISCHARGE ZONE GEOLOGIC AND TCE PLUME PROFILE C – C'			
ROYAL RIVER DISCHARGE ZONE FEASIBILITY STUDY			
McKIN SITE – GRAY, MAINE			
DRAWN BY:	R.G.DEWSNAP	REV.:	0
CHECKED BY:	J. FORRELLI	DATE:	15 JUL 99
SCALE:	1" = 40'	FILE NO.: DWG\MCKIN_1\FEAS_STDY\TCE_PROF.DWG	

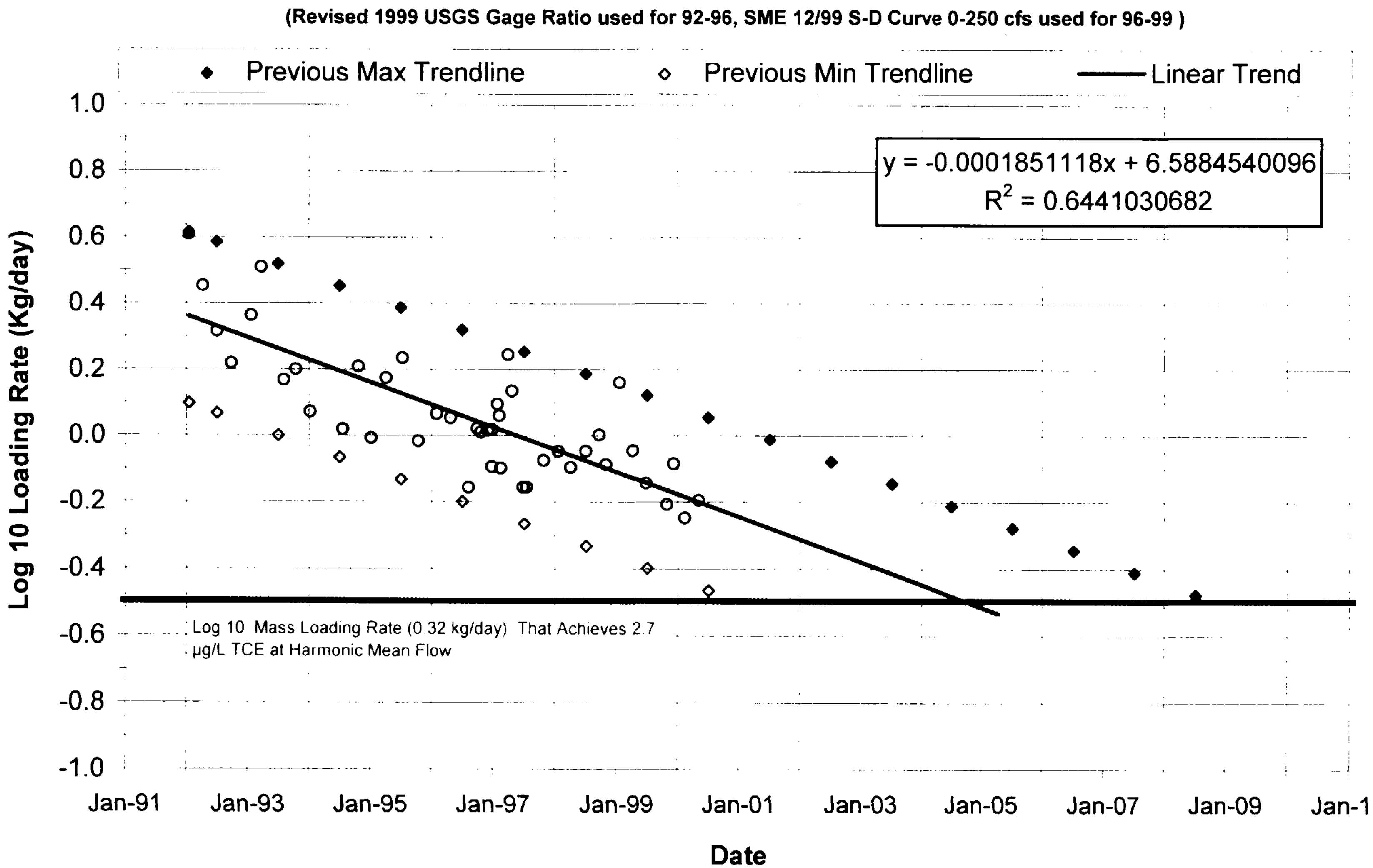
TETRA TECH NUS, INC.

55 Jonspin Road Wilmington, MA 01887
(978)658-7899

Original includes color coding.

Technical Impracticability McKin Site

Figure 17: TCE Mass Flux into the Royal River at SW-1
January 1992 to May 2000



Rrload.xls Chart RR Log Load 0192-P 6/30/00